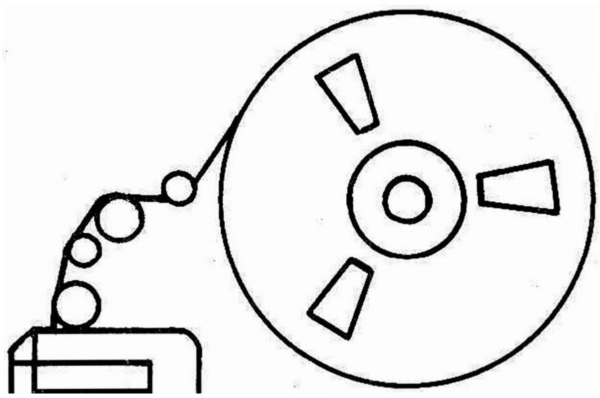
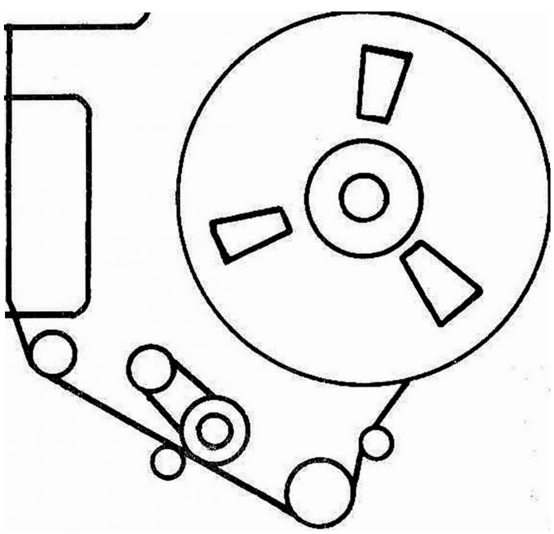




TELEVISION TAPE RECORDER INSTALLATION INFORMATION

TV-41860-B

INSTALLATION INFORMATION

TRT-1B TELEVISION TAPE RECORDER

GENERAL

The RCA Television Tape Recorder is packaged for van shipment and consists of 2 major units for monochrome plus 1 additional unit for color (excluding headwheel panel assemblies and related accessories). The packing design is such as to enable the equipment to be skidded in either an upright or horizontal position. To help protect the equipment in transit, the packing should be left intact and removed only when ready to be placed in its final installation location.

All necessary interconnecting cables are supplied including 2, 50 foot lengths of air hose and 1 interconnecting cable that allows separation of units up to 27 feet.

Any special tools required during the initial installation or set-up of the TV Tape Recorder may be found in the Kit of Accessories, MI-40769-A.

Equipment should be located in a well ventilated room having adequate circulation of dust-free cool air to dissipate the heat generated by the approximate 4 KW power load.

OVERALL DIMENSIONS

Monochrome:		Color:	
Width (5 cabinets in line)	9 ft. 5 1/2 in.	Width (6 cabinets in line)	11 ft. 3 1/2 in.
Height	84 in.	Height	84 in.
Depth	25 in.	Depth	25 in.
Floor area	16 1/2 sq. ft.	Floor area	19.8 sq. ft.

WEIGHT

Control Unit, MI-40768-B (3 racks) 1,450 lbs. includes van packing.

Power Unit, MI-40767-B, 975 lbs. includes van packing.

Color Rack, MI-40766-B, 295 lbs. includes van packing.

INSTALLATION

Interconnection of control unit and power unit is made by use of multi-conductor cable which is already terminated in the control unit. A rundown sheet showing inter-rack cable connections from the control unit to the power unit is located in envelope attached to rear of relay bank in rack 3. Maximum distance between center of control unit and center of power unit is 27 ft., however, on special order longer length interconnecting cable can be provided. All cabling to and from the control and power units may be via the overhead ducts, floor trenches, or through the base of the racks (notched bases are provided). Note: 27 ft. separation between units is based on floor trench installation. If over-head ducts are used, rack separation would have to be reduced to utilize existing inter-rack cable

Be sure shipping supports are removed form the air pump assembly before applying power.

Refer to Figure #1A, B, C, and D, for recommended equipment layout.

POWER REQUIREMENTS

Input power line rating is 117V $\pm$ 5% AC 60 cycles, single or three phase. It is recommended that six 15 amp circuit breakers be provided per tape recorder. Refer to Figure #2 for breakdown of power requirements. When installing the color rack, MI-40766-B, an additional 15 amp breaker is required to supply power to color unit. The utility power input of the color rack may be

connected to the same breaker to which the utility inputs for the control and power units are connected.

Power Table
TRT-1B

AC Terminal Location	Amperage Per Rack	Watts Per Rack
AC Input No. 1 Rack 1 Term. Board 1 Pins 1 & 2	3.5 amps	400 watts
AC Input No. 2 Rack 3 Term. Board 1 Pins 1 & 2	9.5 amps	1050 watts
AC Input 3 Rack 4 Term. Board 1 Pins 1 & 2	8.5 amps	825 watts
AC Input 4 ~~Rack 1~~ RACK 4 Term. Board ~~3~~ 1 Pins 7 & 8	8.0 amps	800 watts
AC Input 5 Rack 5 Term. Board 1 Pins 1 & 2	9.7 amps	975 watts
Monochrome Total	39.2 amps	4050 watts
AC Input 6 (Color Rack) Rack 6 Term. Board 1 Pins 1 & 2	6.0 amps	600 watts
Color Total	45.2 amps	4650 watts
Utility Rack 5 Term. Board 2 Pins 11 & 12		

Utility
Rack 1
Term. Board 1
Pins 9 & 10

Utility
Rack 6
Term. Board 1
Pins 11 & 12

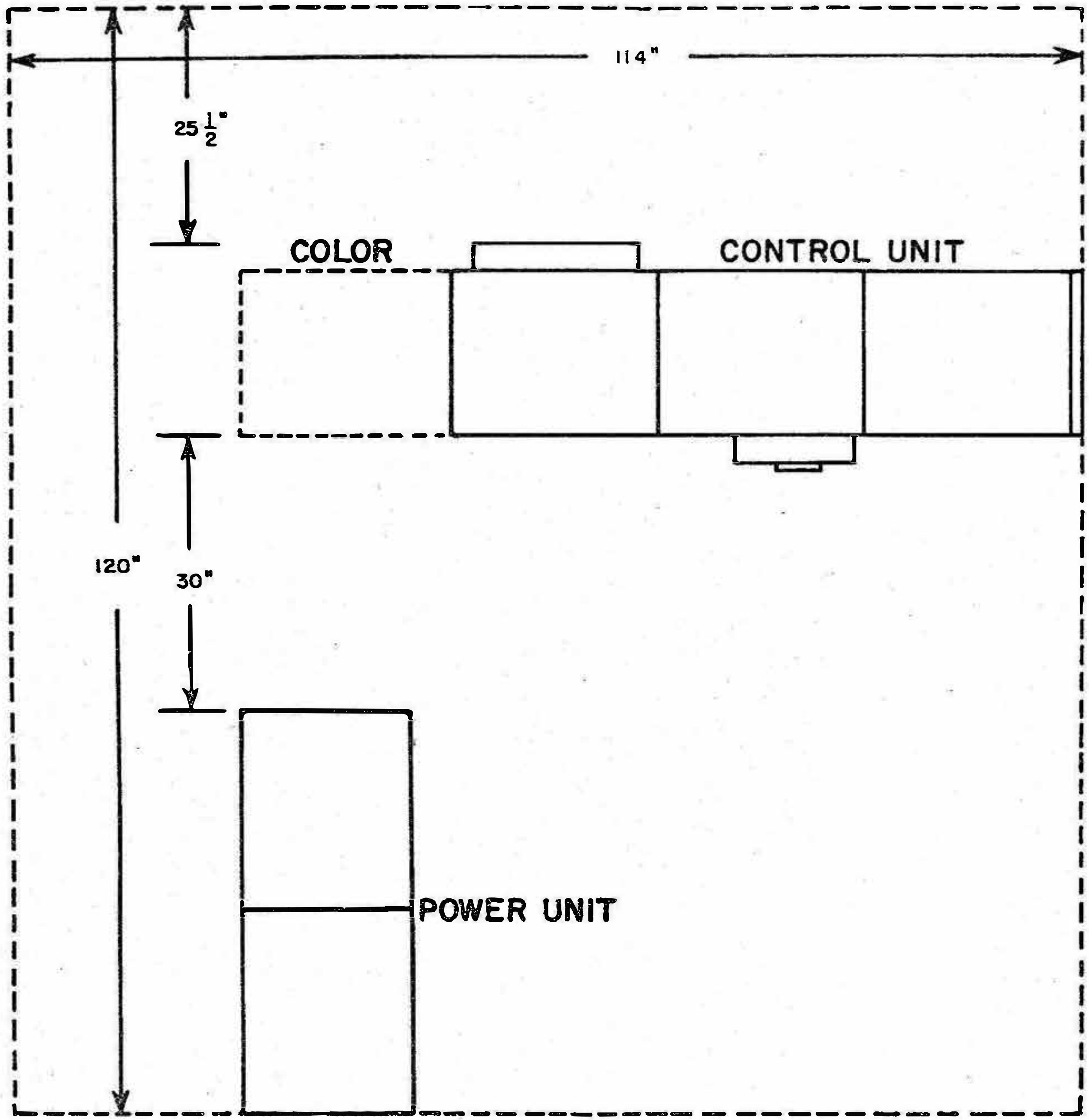
INPUT SIGNALS REQUIRED

Video:	composite video signal in accordance with EIA and FCC specified color/monochrome signal standards. Composite signal level 0.5 to 1.45 V peak to peak. Input circuit may be bridged or terminated in -75 ohms $\pm$ 1% unbalanced.
Program Audio:	-10 to +4 VU into 600 ohm balanced line matching input.
Microphone:	-70 dbm into 150 ohms for recommended full level recording.
Cue Audio:	0 to +8 VU into 600 ohm balanced line matching input.
Microphone:	-70 dbm into 150 ohms for recommended full level recording.
Sync:	4V peak-to-peak terminated 75 ohms.
Subcarrier:	3.58 MC. 1V P-P(used in color operation)
Color Bars:	1V P-P (" " " ")

TEMPERATURE AND HUMIDITY

The TV Tape Recorder will operate satisfactorily in areas where the ambient temperature ranges from 40° to 100° F, however, for best operation the temperature variation should not exceed $\pm$ 10° within this range.

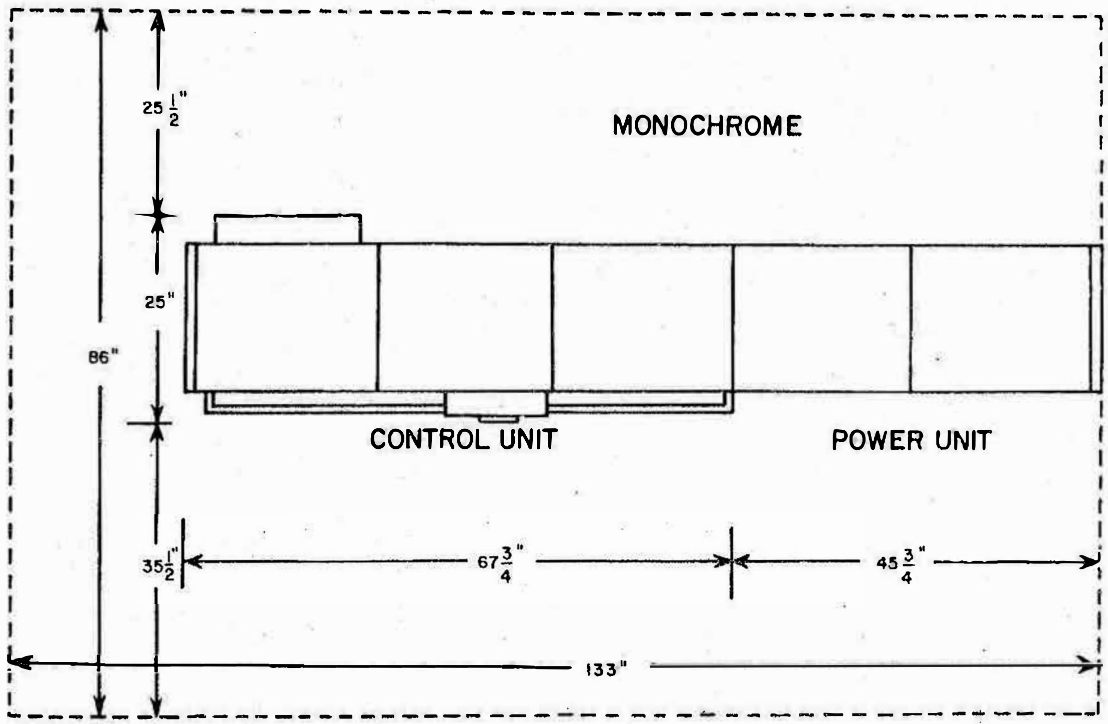
Humidity range may be from 30% to 90%, the limiting factor being the tape itself.

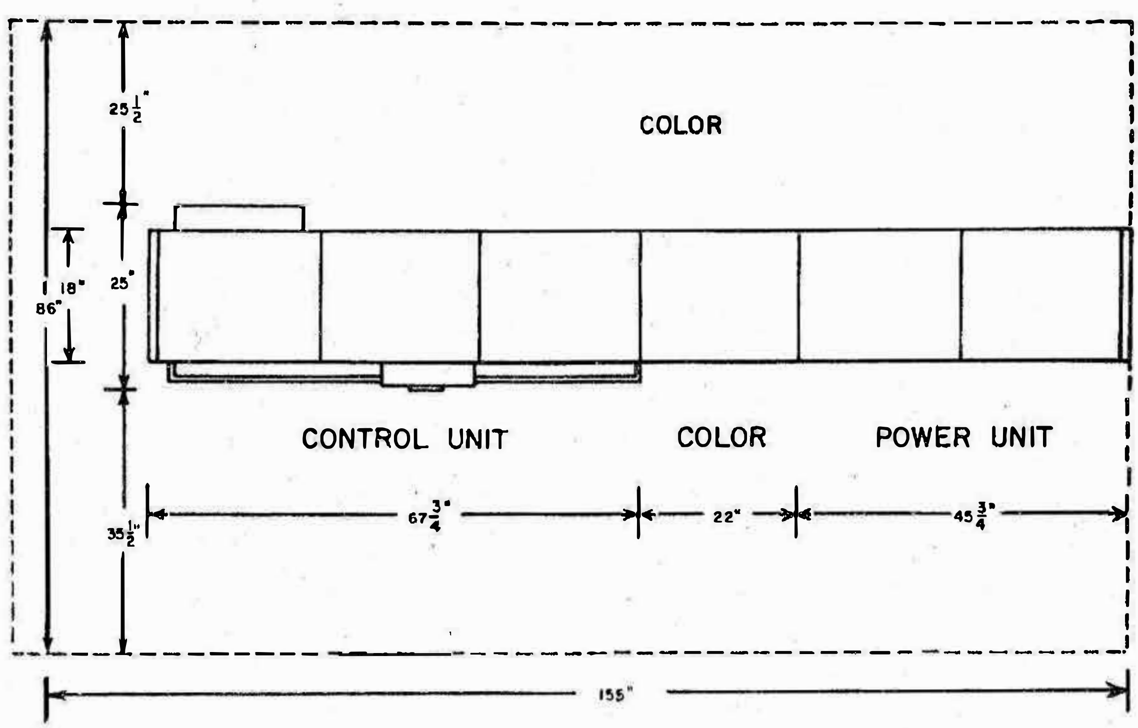


NOTE: COLOR RACK MAY BE LOCATED ON EITHER THE RIGHT OR LEFT SIDE OF THE CONTROL UNIT.

TRT-1A COLOR TAPE RECORDER FLOOR PLAN

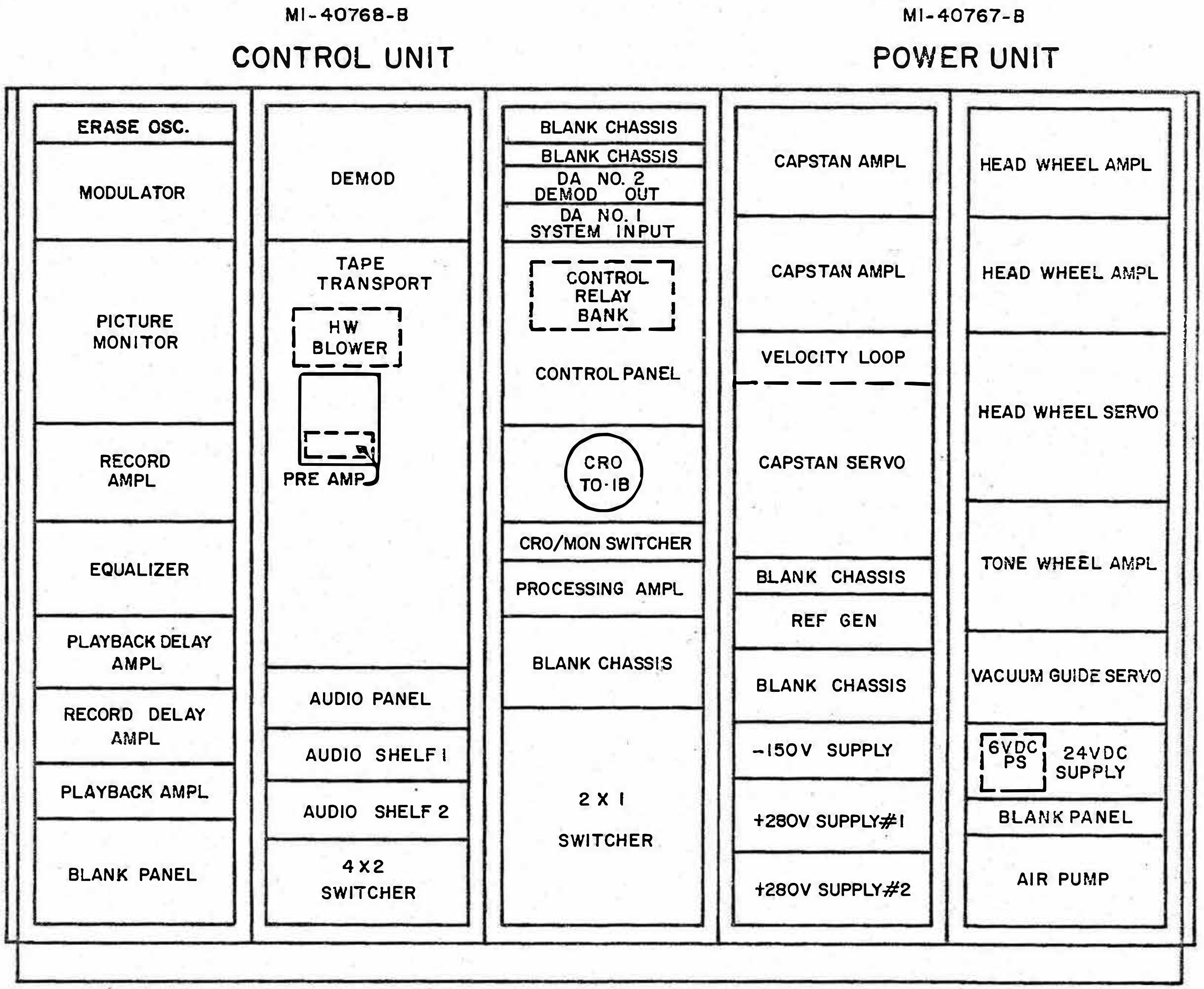
FIG. #1A



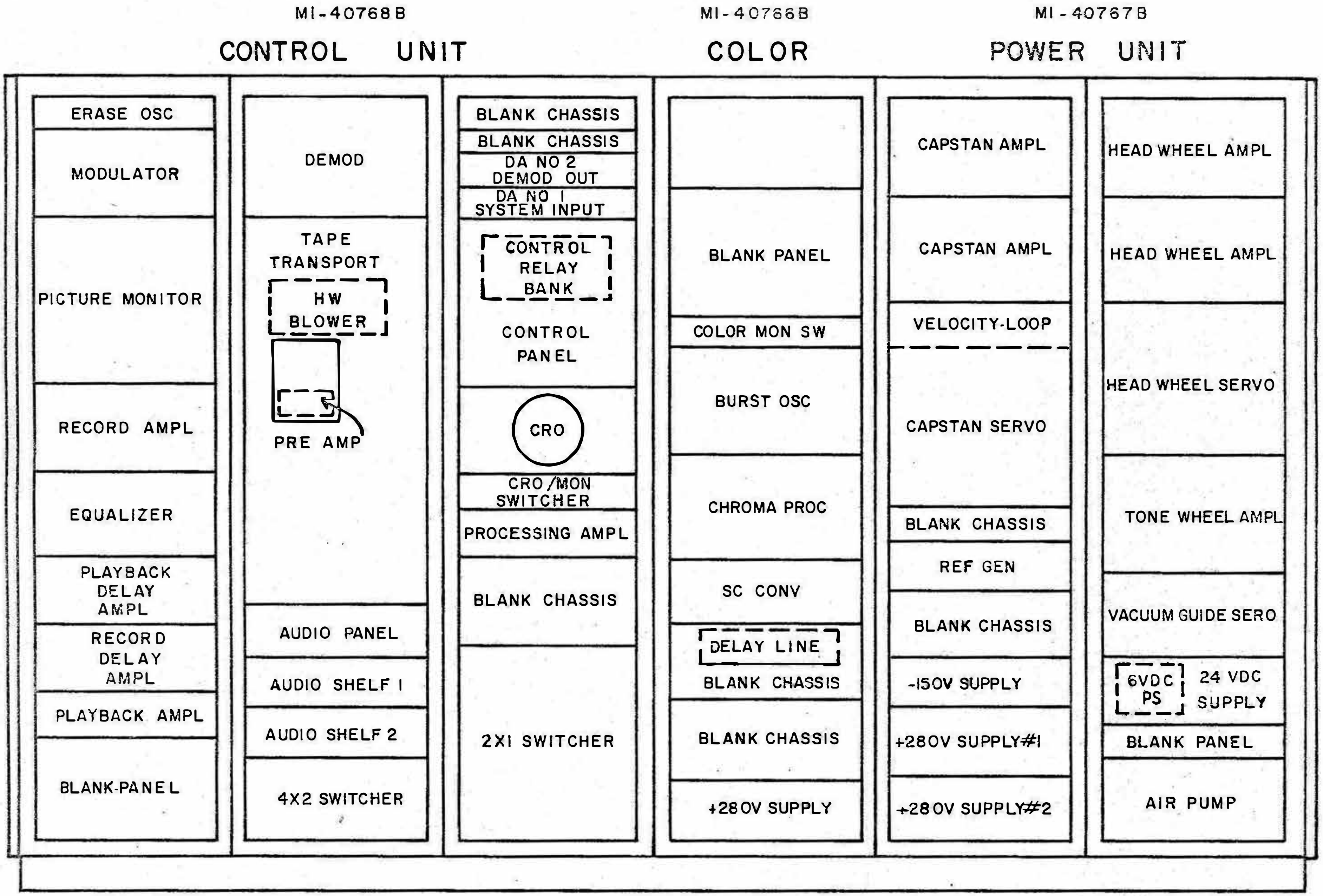


ADDITIONAL TRT-1B FLOOR PLANS

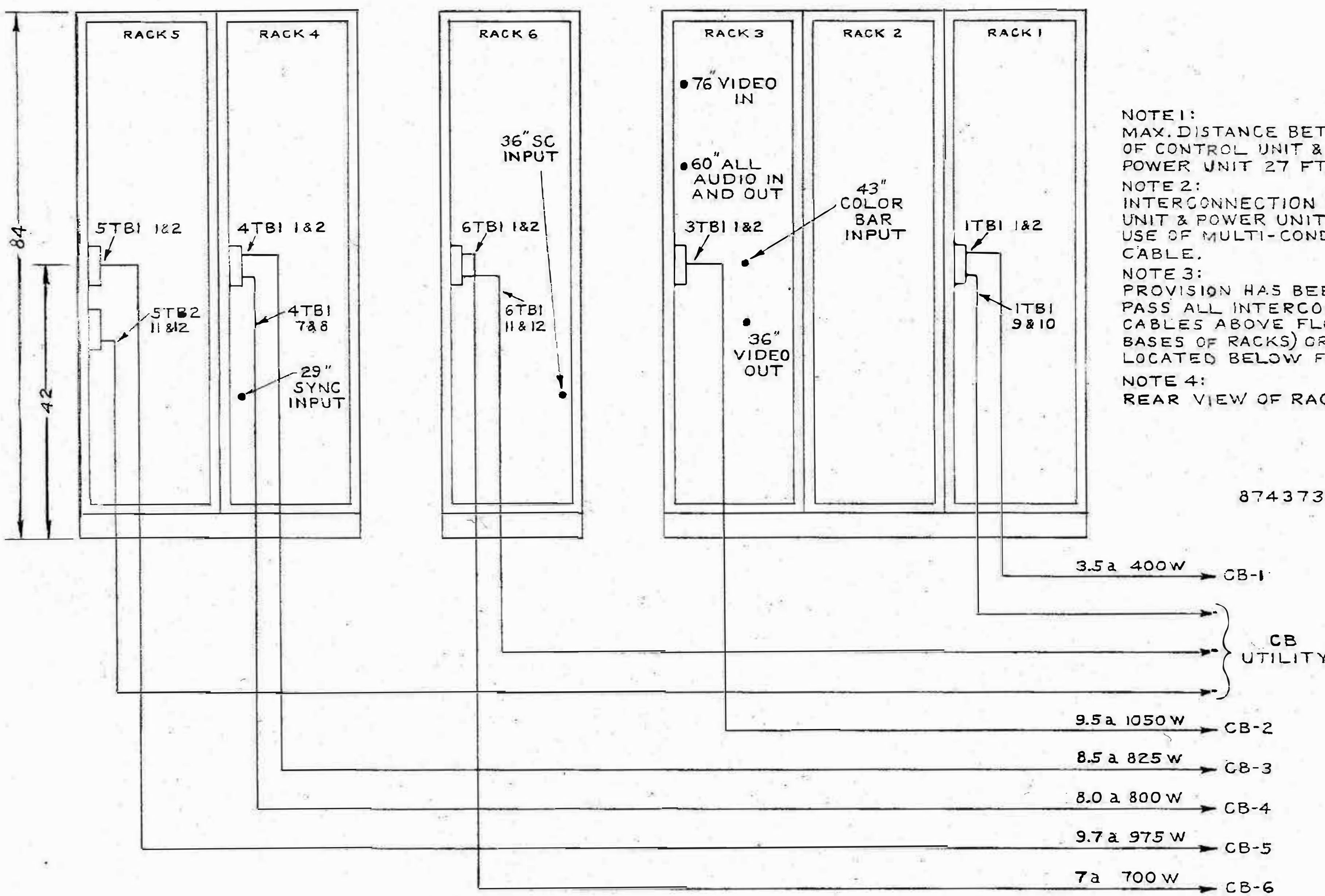
FIG. # 1B



TRT-1B MONOCHROME RACK LAYOUT
FIG. # 1C



TRT-1B COLOR RACK LAYOUT
FIG. # 1D



NOTE 1:
MAX. DISTANCE BETWEEN CENTER OF CONTROL UNIT & CENTER OF POWER UNIT 27 FT.

NOTE 2:
INTERCONNECTION OF CONTROL UNIT & POWER UNIT IS MADE BY USE OF MULTI-CONDUCTOR CABLE.

NOTE 3:
PROVISION HAS BEEN MADE TO PASS ALL INTERCONNECTING CABLES ABOVE FLOOR (THROUGH BASES OF RACKS) OR IN TRENCHES LOCATED BELOW FLOOR LEVEL.

NOTE 4:
REAR VIEW OF RACKS SHOWN.

8743730-0

TRT-1B TAPE RECORDER
EXTERNAL CONNECTION CHART

INSTRUCTION BOOKS

FOR

TRT-1B TV Tape Recorder

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WB 671

IB-30543-1

FIRST AID

WARNING

OPERATION OF ELECTRONIC EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH VOLTAGE SUPPLY ON. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES, ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

Personnel engaged in the installation, operation and maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and in the practical application thereof. It is the duty of every radioman to be prepared to give adequate First Aid and thereby prevent avoidable loss of life.

ARTIFICIAL RESPIRATION

(Courtesy of the American Red Cross)

If victim is not breathing, begin some form of artificial respiration at once. Wipe out quickly any foreign matter visible in the mouth, using your fingers or a cloth wrapped around your fingers.

MOUTH-TO-MOUTH (MOUTH-TO-NOSE) METHOD

Fig. 1

Tilt victim's head back. (Fig. 1). Pull or push the jaw into a jutting-out position. (Fig. 2).

Fig. 2

If victim is a small child, place your mouth tightly over his mouth and nose and blow gently into his lungs about 20 times a minute. If victim is an adult (see Fig. 3), cover the mouth with your mouth, pinch his nostrils shut, and blow vigorously about 12 times a minute.

Fig. 3

If unable to get air into lungs of victim, and if head and jaw positions are correct, suspect foreign matter in throat, To remove it, place victim in position shown in Fig. 4, and slap sharply between shoulder blades.

Fig. 4

Rescuers who cannot, or will not, use mouth-to-mouth or mouth-to-nose technique should use a manual method.

THE BACK PRESSURE-ARM LIFT (HOLGER-NIELSEN) METHOD

Place victim face-down, bend his elbows and place his hands one upon the other, turn his head slightly to one side and extend it as far as possible, making sure that the chin is jutting out. Kneel at the head of the victim. Place your hands on the flat of the victim's back so that the palms lie just below an imaginary line running between the armpits (Fig. 5).

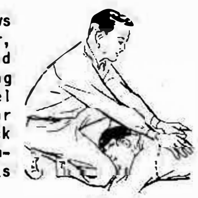


Fig. 5

Rock forward until the arms are approximately vertical and allow the weight of the upper part of your body to exert steady, even pressure downward upon the hands (Fig. 6).

Fig. 6

Immediately draw his arms upward and toward you, applying enough lift to feel resistance and tension at his shoulders (Fig. 7). Then lower the arms to the ground. Repeat this cycle about 12 times per minute, checking the mouth frequently for obstruction.

Fig. 7

If a second rescuer is available, have him hold the victim's head so that the jaw continues to jut out (Fig. 8). The helper should be alert to detect any stomach contents in the mouth and keep the mouth as clean as possible at all times.

Fig. 8

RELATED INFORMATION FOR BOTH METHODS

If vomiting occurs, quickly turn the victim on his side, wipe out his mouth, and then reposition him.

When a victim is revived, keep him as quiet as possible until he is breathing regularly. Keep him from becoming chilled and otherwise treat him for shock. Continue artificial respiration until the victim begins to breathe for himself or a physician pronounces him dead or he appears to be dead beyond any doubt.

Because respiratory and other disturbances may develop as an aftermath, a doctor's care is necessary during the recovery period.

BURNS

FIRST DEGREE BURN

SKIN REDDENED. Temporary treatment—Apply baking soda or Unguentine.

SECOND DEGREE BURN

SKIN BLISTERED. Temporary treatment — Apply baking sode, wet compress, white petroleum jelly, foille jelly, olive oil, or tea.

THIRD DEGREE BURN

FLESH CHARRED. Temporary treatment — Apply baking soda, wet compress, white petroleum jelly, or foille spray. Treat for severe shock.

EQUIPMENT LOST OR DAMAGED IN TRANSIT

When delivering the equipment to you, the truck driver or carrier's agent will present a receipt for your signature. Do not sign it until you have (a) inspected the containers for visible signs of damage and (b) counted the containers and compared with the amount shown on the shipping papers. If a shortage or if evidence of damage is noted, insist that notation to that effect be made on the shipping papers before you sign them.

Further, after receiving the equipment, unpack it and inspect thoroughly for concealed damage. If concealed damage is discovered, immediately notify the carrier, confirming the notification in writing, and secure an inspection report. This item should be unpacked and inspected for damage WITHIN 15 DAYS after receipt. Report all shortages and damages to RCA, Broadcast and Television Department, Camden 2, N. J.

Radio Corporation of America will file all claims for loss and damage on this equipment so long as the inspection report is obtained. Disposition of the damaged item will be furnished by RCA.

REPLACEMENT PARTS AND ENGINEERING SERVICE

RCA field engineering service is available at current rates. Requests for field engineering service may be addressed to your RCA Broadcast Field Representative or the RCA Service Company, Inc., Broadcast Service Division, Camden, N. J. Telephone: WOodlawn 3-8000.

When ordering replacement parts, please give symbol, description, and stock number of each item ordered.

The part which will be supplied against an order for a replacement item may not be an exact duplicate of the original part. However, it will be a satisfactory replacement differing only in minor mechanical or electrical characteristics. Such differences will in no way impair the operation of the equipment. Parts with no stock numbers are standard components. They are not stocked by RCA and should be obtained from your local electronic parts distributor.

The following tabulations list service parts and electron tube ordering instructions according to your geographical location.

SERVICE PARTS

LOCATION	ORDER SERVICE PARTS FROM:
Continental United States, including Alaska and Hawaii	RCA Parts and Accessories Department, P.O. Box 654, Camden, New Jersey or through your nearest RCA Regional Office. Emergency orders may be telephoned, telegraphed, or teletyped to RCA Emergency Service, Bldg. 60, Camden, N. J. (Telephone: WO 3-8000).
Dominion of Canada	RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec or through your local Sales Representative or his office.
Outside of Continental United States, Alaska, Hawaii and the Dominion of Canada	RCA International Division, Clark, N. J., U.S.A. or through your local Sales Representative.

ELECTRON TUBES

LOCATION	ORDER ELECTRON TUBES FROM:
Continental United States, including Alaska and Hawaii	Local RCA Tube Distributor.
Dominion of Canada	RCA Victor Company Limited, 1001 Lenoir Street, Montreal, Quebec or through your local Sales Representative or his office.
Outside of Continental United States, Alaska, Hawaii and the Dominion of Canada	Local RCA Tube Distributor or from: Tube Department RCA International Division 30 Rockefeller Plaza New York 20, New York, U.S.A.

RETURN OF ELECTRON TUBES

If for any reason, it is desired to return tubes, please return them through your local RCA tube distributor, RCA Victor Co. Ltd., or RCA International Div., depending on your location.

Please do not return tubes directly to RCA without authorization and shipping instructions.

It is important that complete information regarding each tube (including type, serial number, hours of service and reason for its return) be given. When tubes are returned, they should be shipped to the address specified on the Return Authorization form. A copy of the Return Authorization and also a Service Report for each tube should be packed with the tubes.

LIST OF RCA SALES OFFICES

Atlanta 3, Georgia
1121 Rhodes-Haverty Bldg.
134 Peachtree St. N.W.
JAckson 4-7703

Boston 16, Mass.
Room 2301, John Hancock Bldg.
200 Berkley St.
HUbbard 2-5765

Camden 2, N. J.
Building 15
WOodlawn 3-8000

Charlotte 4, N. C.
504 Charlottetown Mall
333-3996

Chicago 54, Ill.
1186 Merchandise Mart Plaza
DElaware 7-0700

Cleveland 15, Ohio
1600 Keith Bldg.
CHerry 1-3450

Dallas 35, Texas
7901 Empire Freeway
FLeetwood 2-3911

Detroit 39, Mich.
12605 Arnold St.
KEnwood 4-5100

Hollywood 28, Calif.
RCA Bldg., 1560 N. Vine St.
HOllywood 9-2154

Indianapolis, Ind.
501 N. LaSalle St.
MElrose 6-5321

Kansas City 15, Missouri
7711 State Line Road
EMerson 1-6770

New York 20, New York
36 W. 49th St.
JUdson 6-3800

Paterson, N. J.
495 E. 30th St.
MUlberry 4-0972

Portland 5, Oregon
1208 S.W. 14th St.
CApitol 6-6828

San Francisco 2, Calif.
420 Taylor St.
ORdway 3-8027

Seattle, Washington
2250 First Ave., S.
MAin 2-8350

Washington 6, D. C.
1725 K St., N.W.
FEderal 7-8500

CONTENTS

* The codes are abbreviations of the unit names. They are used as prefixes to page numbers and are also printed on the index tabs (except for the books in the *Audio Shelf* sections which have no tabs).

** The first digit of the unit number indicates the rack in which the unit is mounted, and the third digit, generally indicates the position of the unit starting from the top of the rack. (In some instances, because of design changes, the unit number does not correspond to chassis position. See the *Rack Layout Diagram,* figure IN-1, in the *Introduction* section.)

† For Cue Line Amplifier, Unit 206A, see *Preamplifier, Type BA-21A* under AS-1.

CONTENTS (Continued)

‡ For Headwheel Servo Amplifiers, Units 502 and 503 see *Servo Power Amplifiers (SA)* under *Rack 4.*

§ For Unit 610 see *280-Volt Power Supply (PPS)* under *Rack 4.*

INTRODUCTION

This loose-leaf binder contains separate instruction books on the individual units of the TRT-1B Television Tape Recorder. Since the information is intended as an aid to maintenance of the individual units the books are arranged in the same sequence as the units in the racks—one major division for each of the five monochrome racks, with the first book in each section corresponding to the unit at the top of the rack (except when one book serves two or more similar units in different locations).

NOTE: When the accessory color rack is ordered, a sixth section containing books on the color chassis is shipped with the rack.

Separator sheets with projecting tabs are provided to make the volume self-indexing. Red tabs locate the rack sections and shorter buff-colored tabs, the unit books. A code representing the name of the unit is printed on each short tab. (The codes are identified in the table of *Contents.*)

Contents of Individual Books

Each book contains detailed information on the particular unit and enough system information to permit relating the unit to the rest of the machine. Although the contents of individual books vary, each book generally contains the following items:

A. Front view photograph.

B. Technical Data table.

C. Block diagram.

D. Description.

   1. Function of unit in tape recorder.
   2. Circuit.
      a. Simplified schematics.
      b. Waveforms.

E. Setup For Operation—how to adjust front panel controls. (For reference only—complete operating procedure is given in separate *Operation Manual.*)

F. Maintenance.

   1. Alignment and other maintenance adjustments.
      a. Test equipment required.
      b. Typical waveforms.
   2. Trouble shooting.
      a. Trouble shooting hints or chart.
      b. Typical waveforms.
   3. Parts Replacement.
      a. Mechanical assembly and disassembly (where required).
      b. List of parts.
      c. Photographs with parts identified.
      d. Wiring diagram (where required).
   4. Schematic diagram on extended page—tube socket voltage table on apron (usually)—point-to-point voltages on diagram itself.

Rack Interconnection Diagrams and Rack Parts Lists

To permit tracing chassis and rack wire connections (not coaxial cables) an interconnection diagram is included at the beginning of each rack section. A list of replacement parts for the rack itself is included on the apron of the diagram. (Replacement parts for the units in the rack are given in the individual books.)

NOTE: Coaxial cable connections are shown in the *Video Functional Diagram,* figure IN-4, at the end of this section. Connections between the Operations Center (Racks 1, 2, 3) and the Servo Unit (Racks 4, 5) made by the main installation cable are listed in figure IN-2.

Additional Instruction Books on Overall Systems

Overall system information on the tape recorder will be provided shortly in the following four additional books:

1. *Description, TRT-1B TV Tape Recorder*

2. *Operation Manual for TRT-1B TV Tape Recorder*

3. *System Maintenance Manual, TRT-1B TV Tape Recorder*

4. *Instructions, Color Processing System for TRT-1B TV Tape Recorder.* (To be shipped with books on individual color chassis when accessory color rack is ordered.)

System Diagrams

The diagrams at the end of this section provide essential system information on the tape recorder. A description of each diagram is given in the following table:

SYSTEM DIAGRAMS

Figure No.	*Title*	*Description*
	INSTALLATION DIAGRAMS	
IN-1	Rack Layout, Monochrome	Typical floor-plan—Location of units in each rack by name and unit number—arrangement of chassis on two audio shelves.
IN-2	Inter-rack Connections	List of connections between racks made by main installation cables.
IN-3	External AC Connections	Connections to circuit breakers—Load on each circuit breaker.
	VIDEO AND SERVO SYSTEM DIAGRAMS	
IN-4	Video Functional, Monochrome	Shows signal flow of video, fm, and servo units, coaxial cable connections, and terminations.
IN-5	Waveform Diagram	Shows relative timing of main servo and switching pulses, head scanning intervals, and sync.
	AUDIO SYSTEM DIAGRAMS	
IN-6	Audio Functional	Simplified block diagram showing audio signal flow.
IN-7	Audio System Schematic	Combined schematic and block diagram showing connections between audio units.
IN-8	Audio Shelf Wiring	Wiring between plug-in connectors, terminal boards and other components on two audio shelves.
	CONTROL AND DC POWER SYSTEM DIAGRAMS	
IN-9	Control Functional	Block diagram showing (very generally) which relays are controlled by pushbuttons on control panel or by other relays.
IN-10	Wiring Diagram, Control Panel and Relay Bank	Wiring to connectors on control panel and relay bank.
IN-11	DC Power Distribution	Shows how power from 280-volt and —150-volt dc supplies is distributed to the various units, and which units of the video and fm system are energized in record or playback modes.

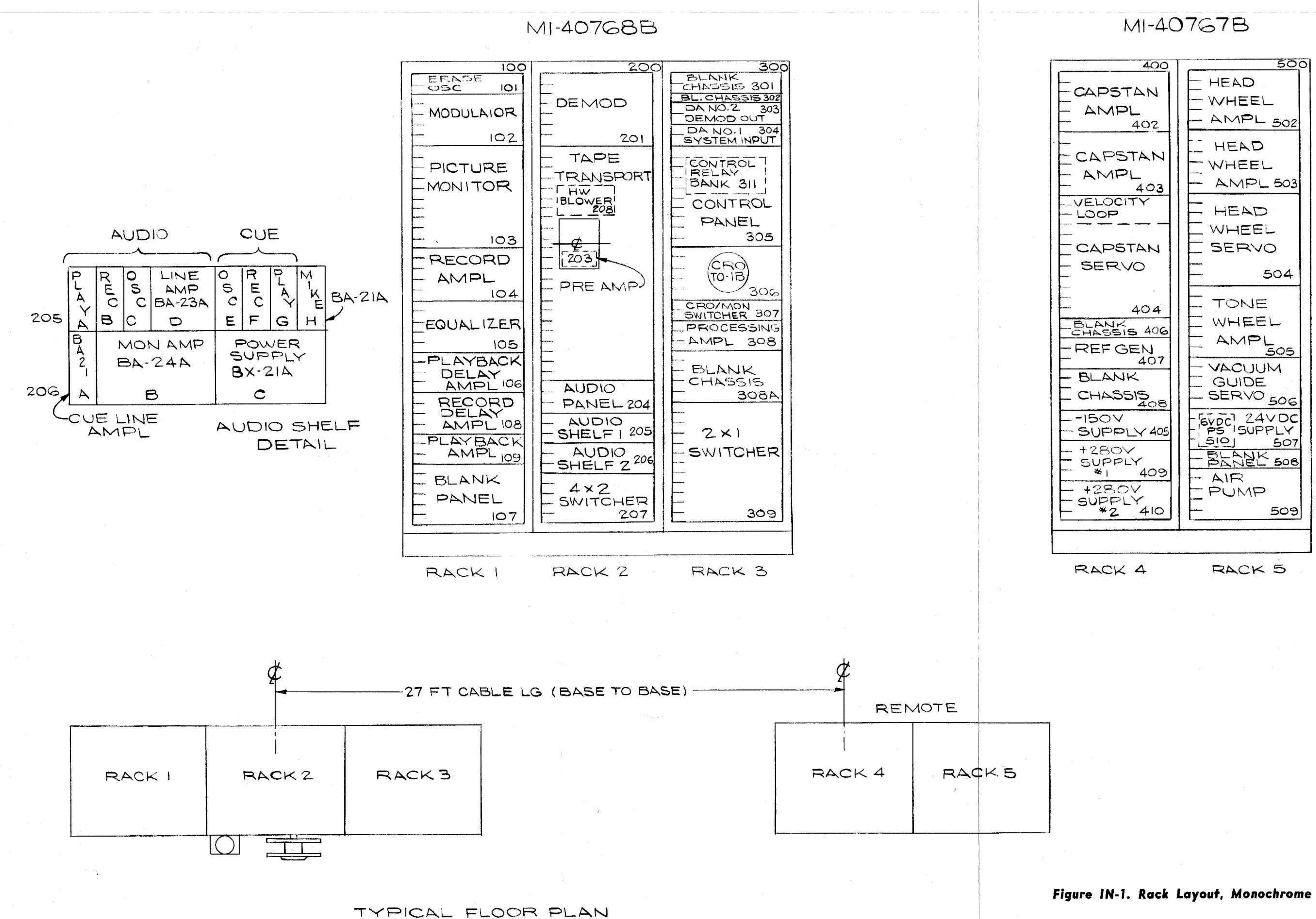


Figure IN-1. Rack Layout, Monochrome

INTERRACK CABLE CONNECTIONS

MI - 40768-B

Rack 4

4TB2-4		White/Green/Blue	311J22-F
4TB2-5		White/Green/Violet	311J22-D
4TB2-6		White/Green/Gray	311J22-B
4TB2-7	White Cable	Red	2TB3-5
4TB2-8		Black	2TB3-6
4TB2-8		Shield	2TB3-8
4TB2-9		Green	2TB3-7
404-J2-5	Yellow Cable	Shield	2TB4-9
404-J2-7		White/Yellow/Red	2TB4-7
404-J2-8		White/Yellow/Black	2TB4-8
404-J2-2	Orange Cable	White/Orange/Black	2TB4-11
404-J2-1		White/Orange/Red	2TB4-10
404-J2-3		Shield	2TB4-12
404-J8-NC		White/Brown/Brown/Orange	305-J15-B
404-J8-1		White/Brown/Brown/Yellow	305-J15-C
404-J8-8		White/Brown/Brown/Green	305-J15-A
404-J8-2		White/Brown/Brown/Blue	305-J15-K
404-J8-4		White/Brown/Brown/Violet	305-J15-J
404-J8-6		White/Brown/Brown/Grey	305-J15-R
404-J8-7		White/Brown/Orange/Black	305-J15-X
404-J8-9		White/Brown/Orange/Brown	305-J15-V
404-J8-12		White/Brown/Orange/Red	305-J15-U
404-J8-15		White/Brown/Orange/Orange	305-J15-P
404-J8-3		White/Green/Brown	305-J15-M
404-J8-11		White/Green/Red	305-J15-S
409-J4-10		White/Red	1TB2-3
		White/Red/Red	1TB2-1
409-J4-12		White/Orange	1TB2-4
		White/Red/Brown	1TB2-2
410-J4-10		White/Red/Orange	3TB2-5
		White/Red/Green	3TB2-1
		White/Red/Violet	3TB2-3
		White/Red/Black	2TB2-1
410-J4-12		White/Red/Yellow	3TB2-6
		White/Red/Blue	3TB2-2
		White/Red/Grey	3TB2-4
		White/Red/Brown/Black	2TB2-2

Rack 5

5TB1-9	Blue Cable	Shield	2TB3-4
5TB1-10		White/Blue/Red	2TB3-1
5TB1-11		White/Blue/Black	2TB3-2
5TB1-12		White/Blue/Green	2TB3-3
5TB2-8		White/Green/Orange	311-J31-2
5TB2-9		White/Green/Yellow	311-J31-3
5TB3-1		White/Black/Green	3TB3-1
		White/Black/Blue	
5TB3-2		White/Black/Violet	3TB3-2
		White/Brown	
5TB3-4		White/Blue	2TB4-3
5TB3-5		White/Violet	2TB4-4
5TB3-6		White/Brown/Grey	3TB2-7
5TB3-7		White/Brown/Black	3TB2-8
505-J1-1	Brown Cable	White/Brown/Red	2TB3-10
505-J1-2		White/Brown/Black	2TB3-11
505-J1-3		Shield	2TB3-12
506-J1-11		White/Green/Brown/Brown	305-J16-M
506-J1-12		White/Green/Brown/Red	305-J16-P
506-J1-9		White/Green/Brown/Orange	305-J16-R
506-J1-10		White/Green/Brown/Yellow	305-J16-C
506-J1-7		White/Green/Brown/Green	305-J16-K
506-J1-4		White/Blue/Yellow	305-J16-A
506-J1-3		White/Blue/Green	305-J16-H
506-J1-1		White/Blue/Brown	305-J16-B
506-J1-8	Green Cable	White/Green/Red	309-J13-15
506-J1-6		White/Green/Black	309-J13-16
506-J1-6		Shield	309-J13-NC
506-J1-5		White/Blue/Red	309-J13-13
506-J1-2		White/Blue/Orange	309-J13-14

Rack 5 continued

506-J5-11		White/Black/Orange	200-TB6-3
506-J5-12		White/Black/Yellow	200-TB6-4
506-J5-9		White/Black/Red	200-TB6-2
506-J5-10		White/Black/Brown	200-TB6-1
506-J5-7	Red Cable	White/Red/Red	200-TB6-8
506-J5-12		White/Red/Black	200-TB6-6
506-J5-8		White/Red/Green	200-TB6-7
506-J5-12		Shield	N. C.

COAXIAL CABLES

Unit & Plug	Circuit	Color	Unit & Plug
Ref Gen 407-J12	Mon Sync	White/Black	Monitor 103-J3
H. W. Servo 504-J4	240 TW	White/Brown	4X2 SW 207-J2
Ref Gen 407-J8	Sep Sync	White/Red	Proc Amp 308-J21
H. W. Servo 504-J2	60 REF	White/Orange	CRO/MON 307-J8
Cap Servo 404-J4	Mon CT REC	White/Yellow	CRO/MON 307-J13
Cap Servo 404-J3	Mon CT PB	White/Green	CRO/MON 307-J15
Ref Gen 407-J7	Local Sync	White/Blue	CRO 306-J6
Cap Servo 404-J10	CAP SAW	White/Violet	CRO/MON 307-J20
H. W. Servo 504-J8	H. W. Lock	White/Grey	CRO/MON 307-J19
Guide Servo 506-J4	960 TW	White	2X1 SW 309-J4

Figure IN-2. Inter-rack Connections (Installation Cable Connections Between Servo Unit, Racks 4 and 5, and Operations Center, Racks 1, 2, and 3)

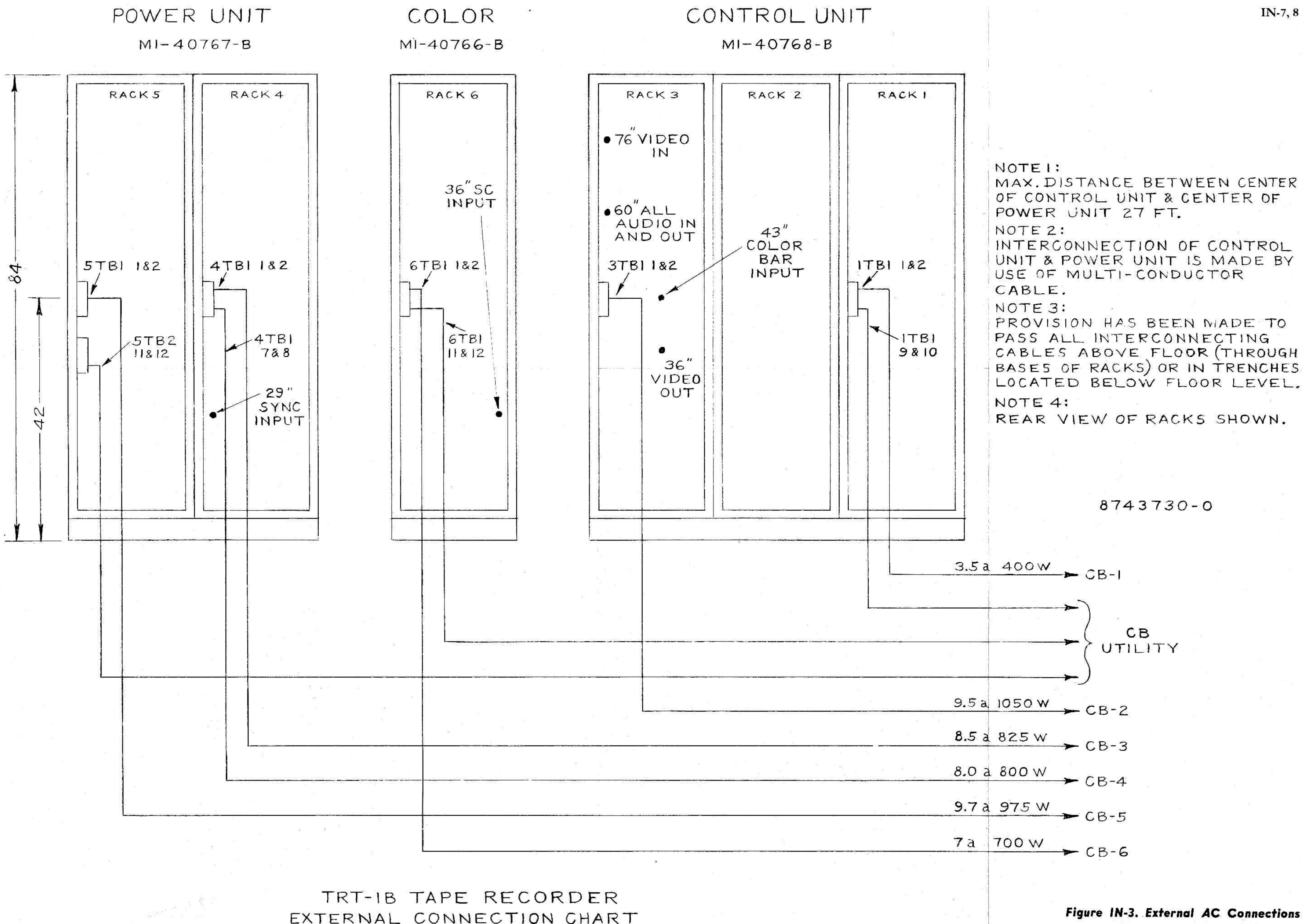


Figure IN-3. External AC Connections

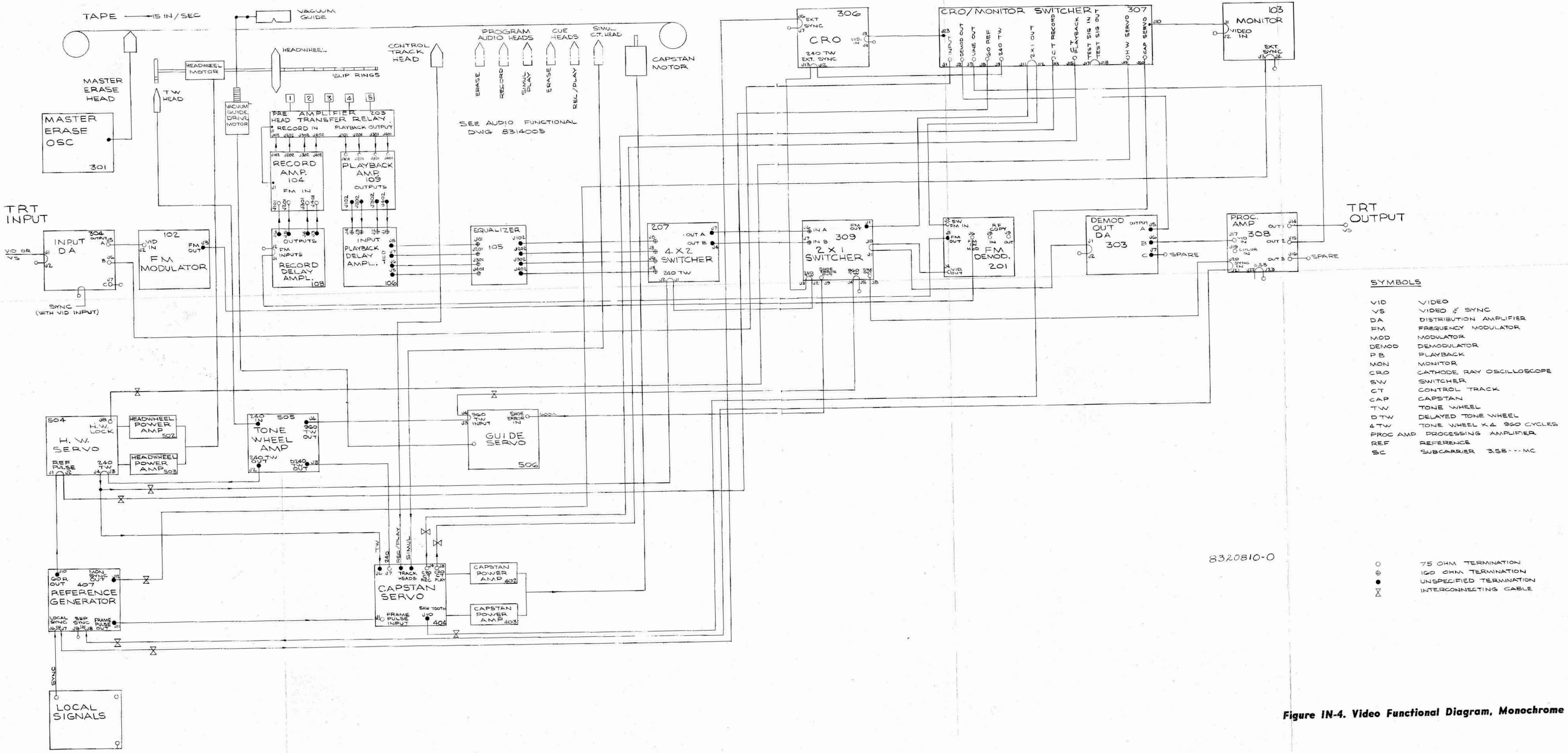


Figure IN-4. Video Functional Diagram, Monochrome

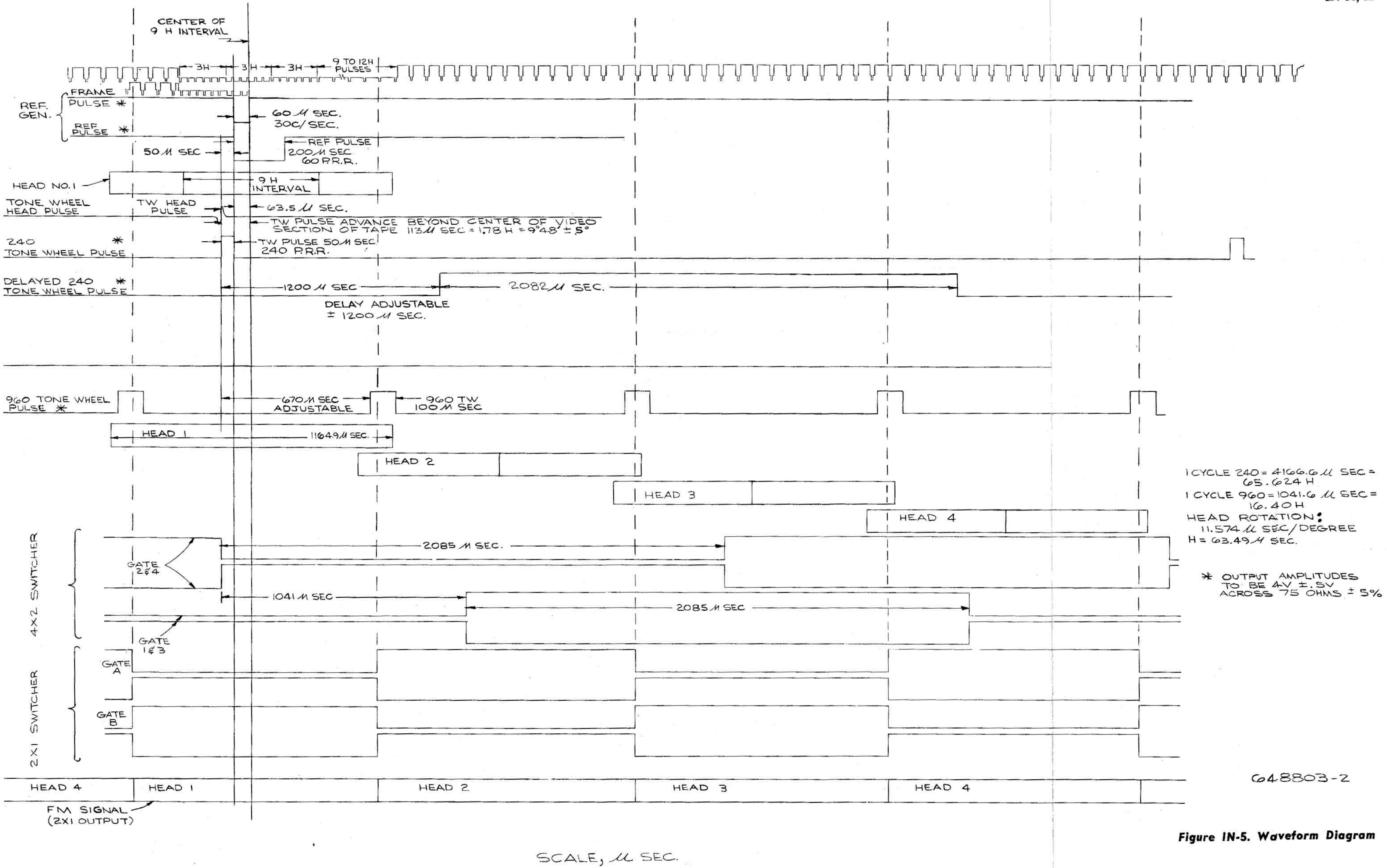


Figure IN-5. Waveform Diagram

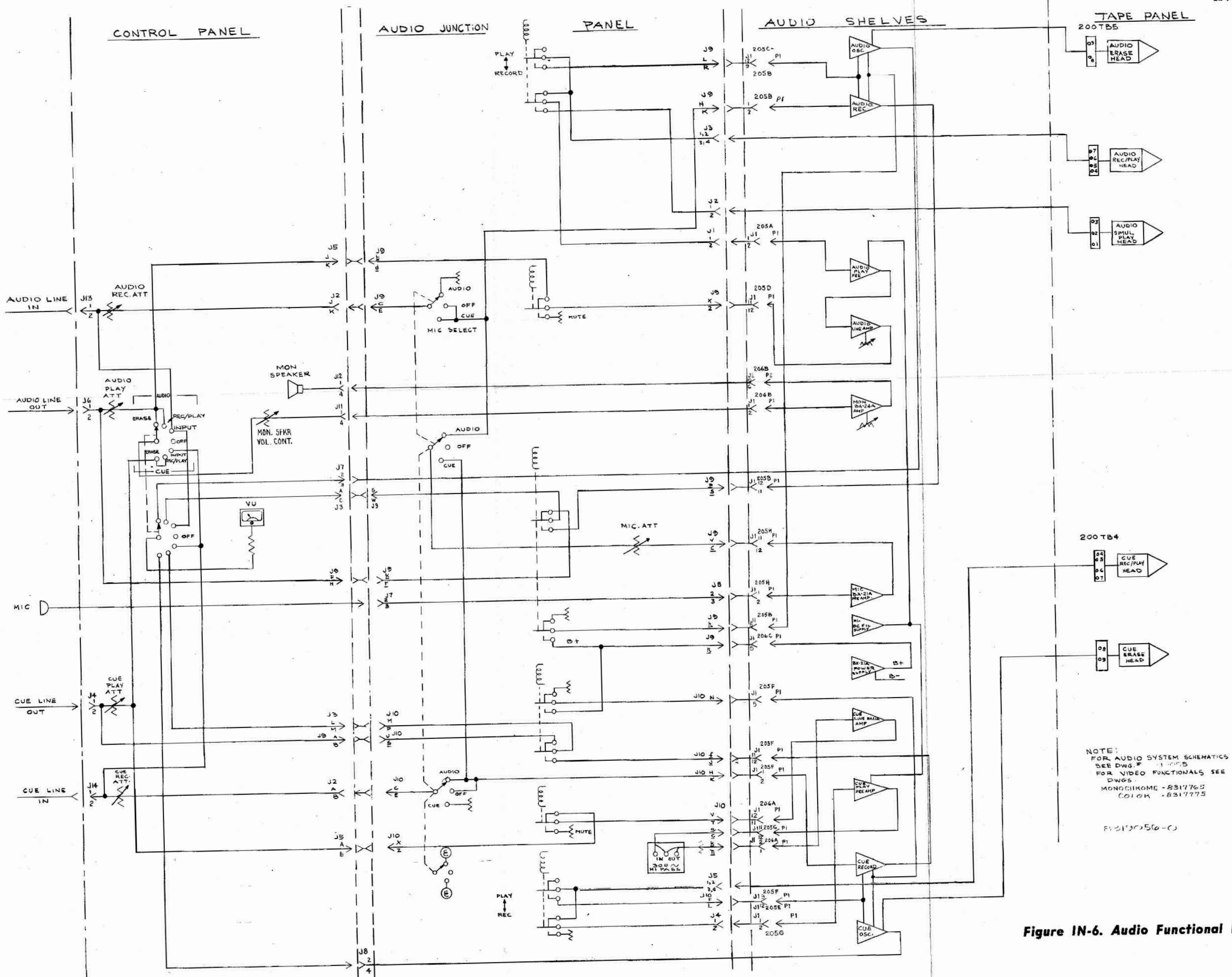
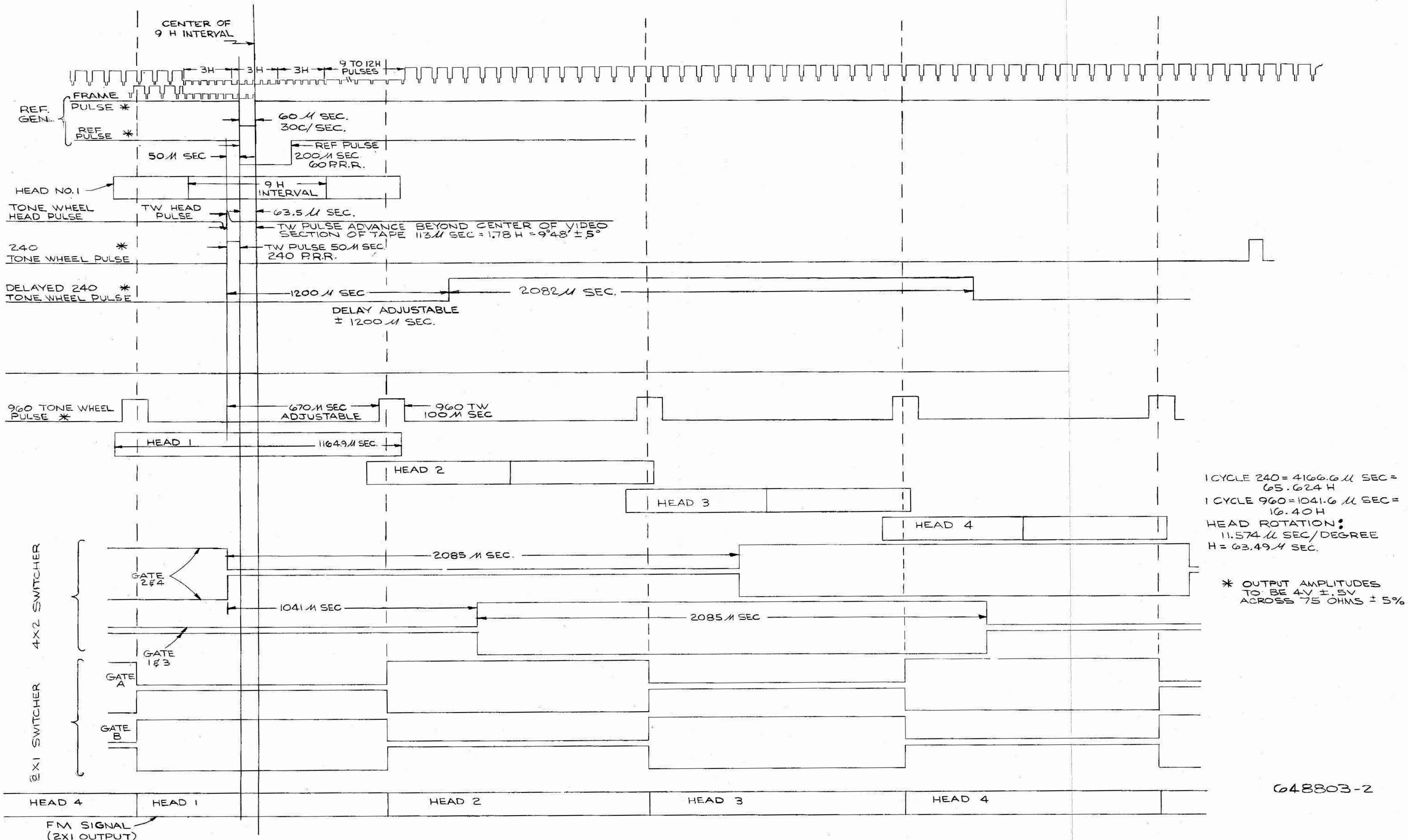


Figure IN-6. Audio Functional Diagram



SCALE, µ SEC.

Figure IN-5. Waveform Diagram

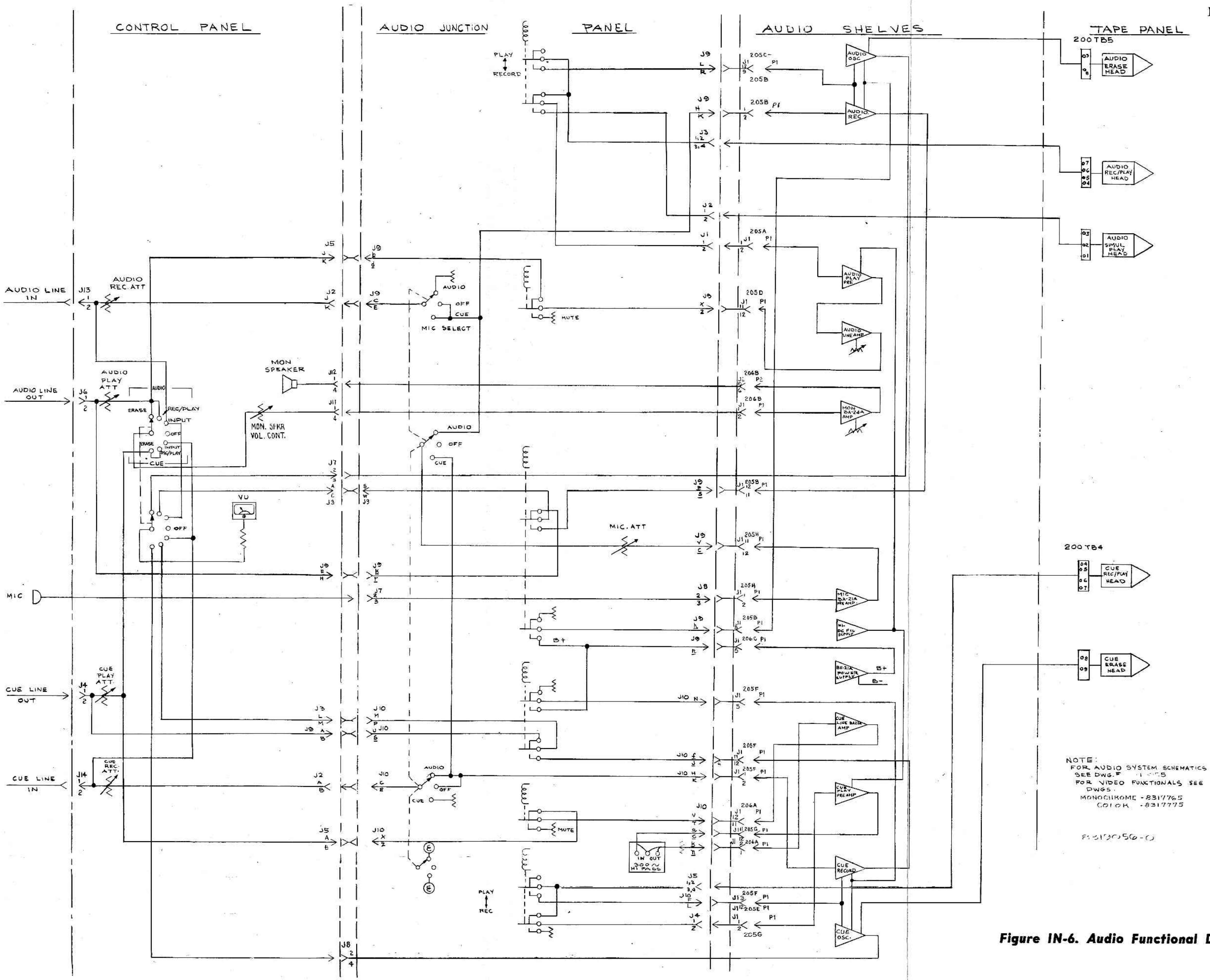


Figure IN-6. Audio Functional Diagram

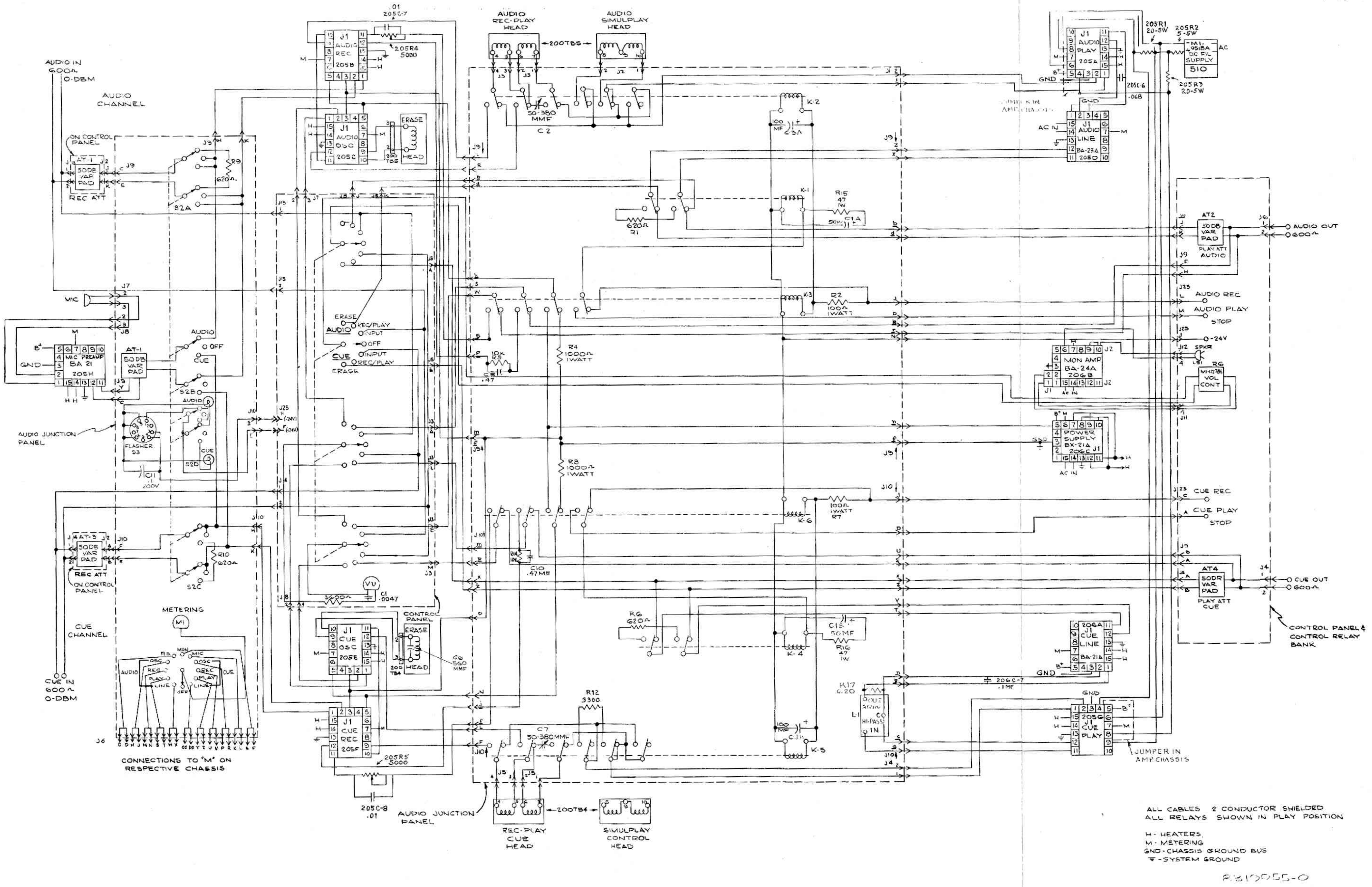
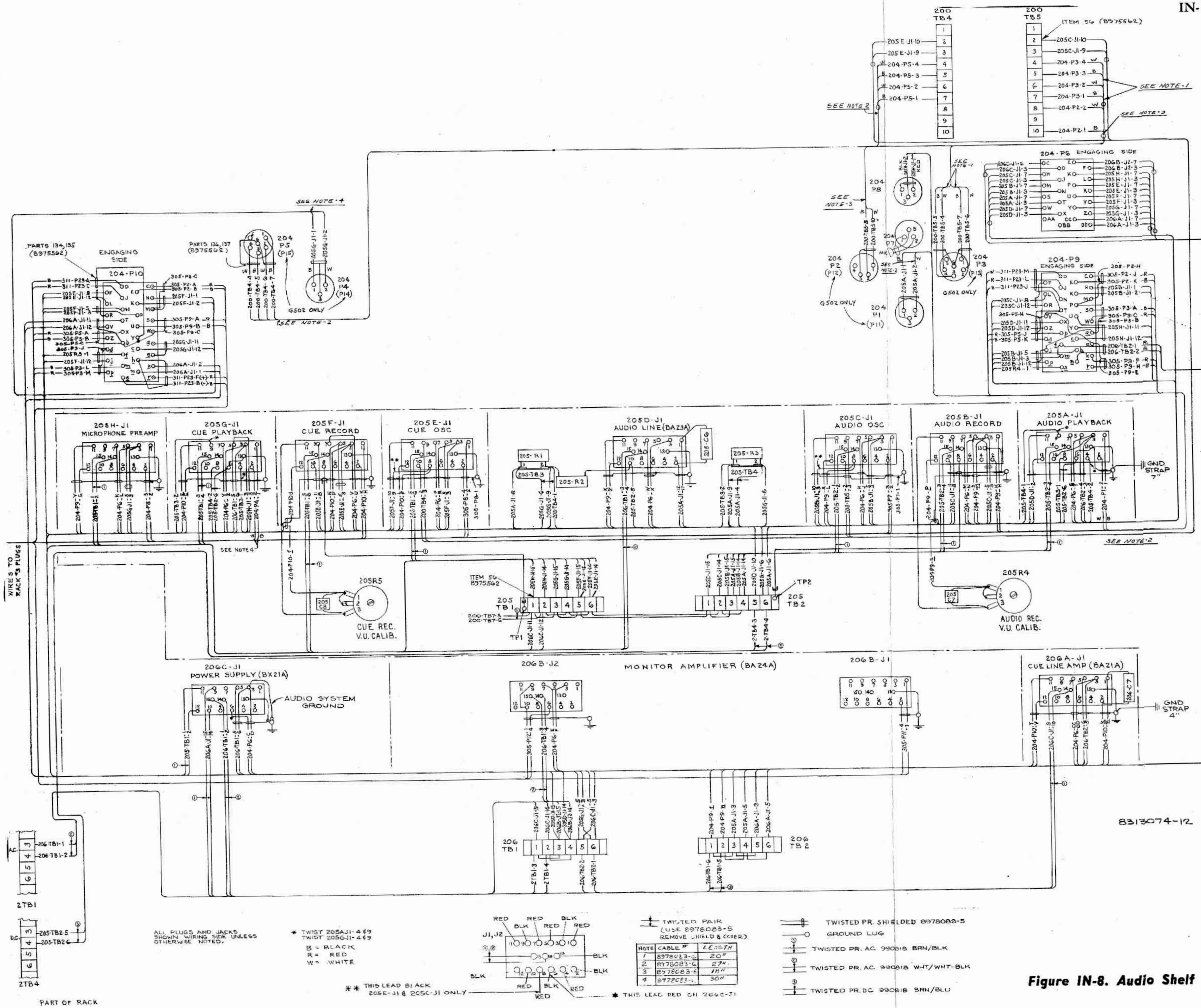


Figure IN-7. Audio System Schematic



NOTE	CABLE #	LENGTH
1	8978083-6	20"
2	8978083-6	27"
3	8978083-6	18"
4	8978083-6	30"

Figure IN-8. Audio Shelf Wiring

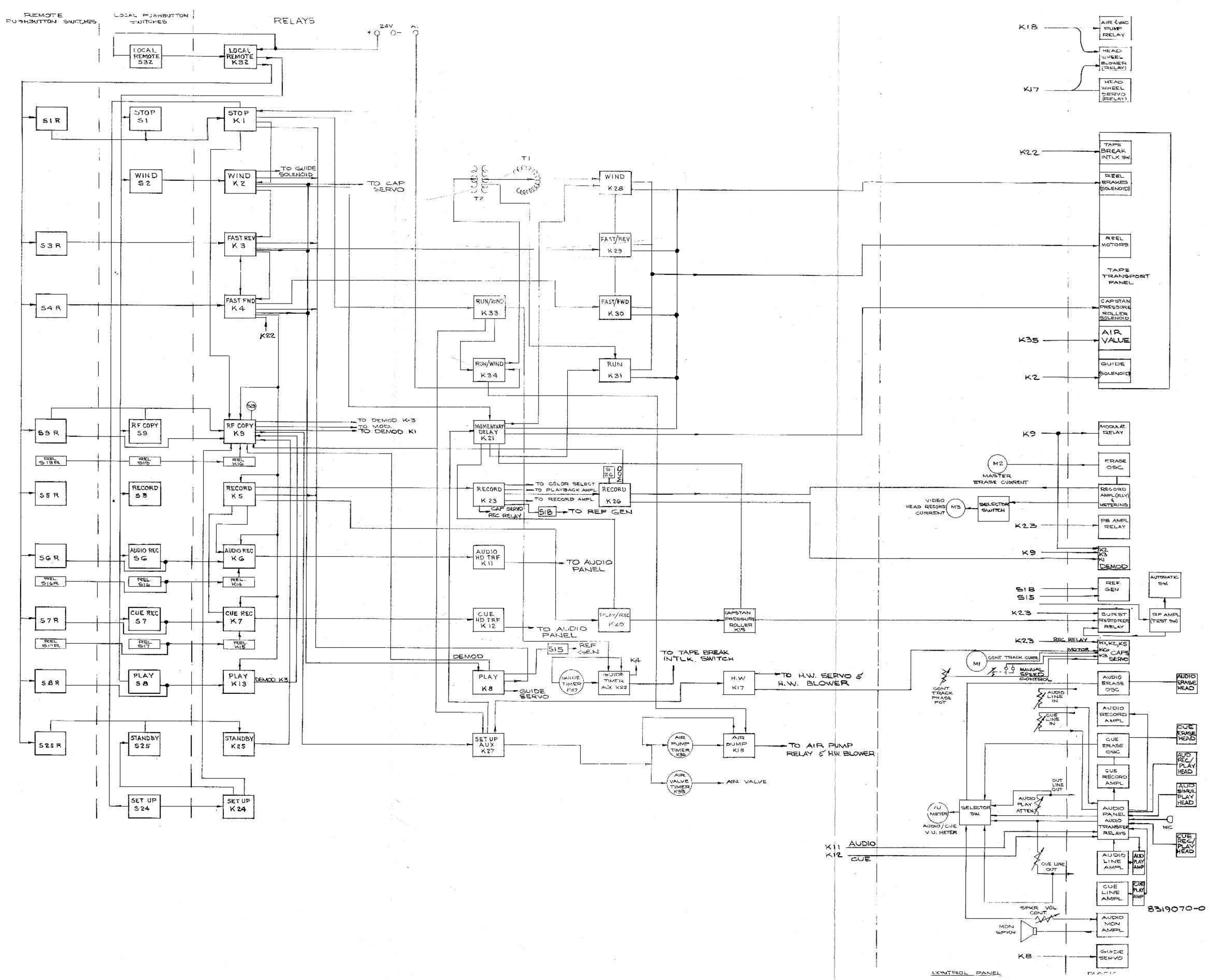
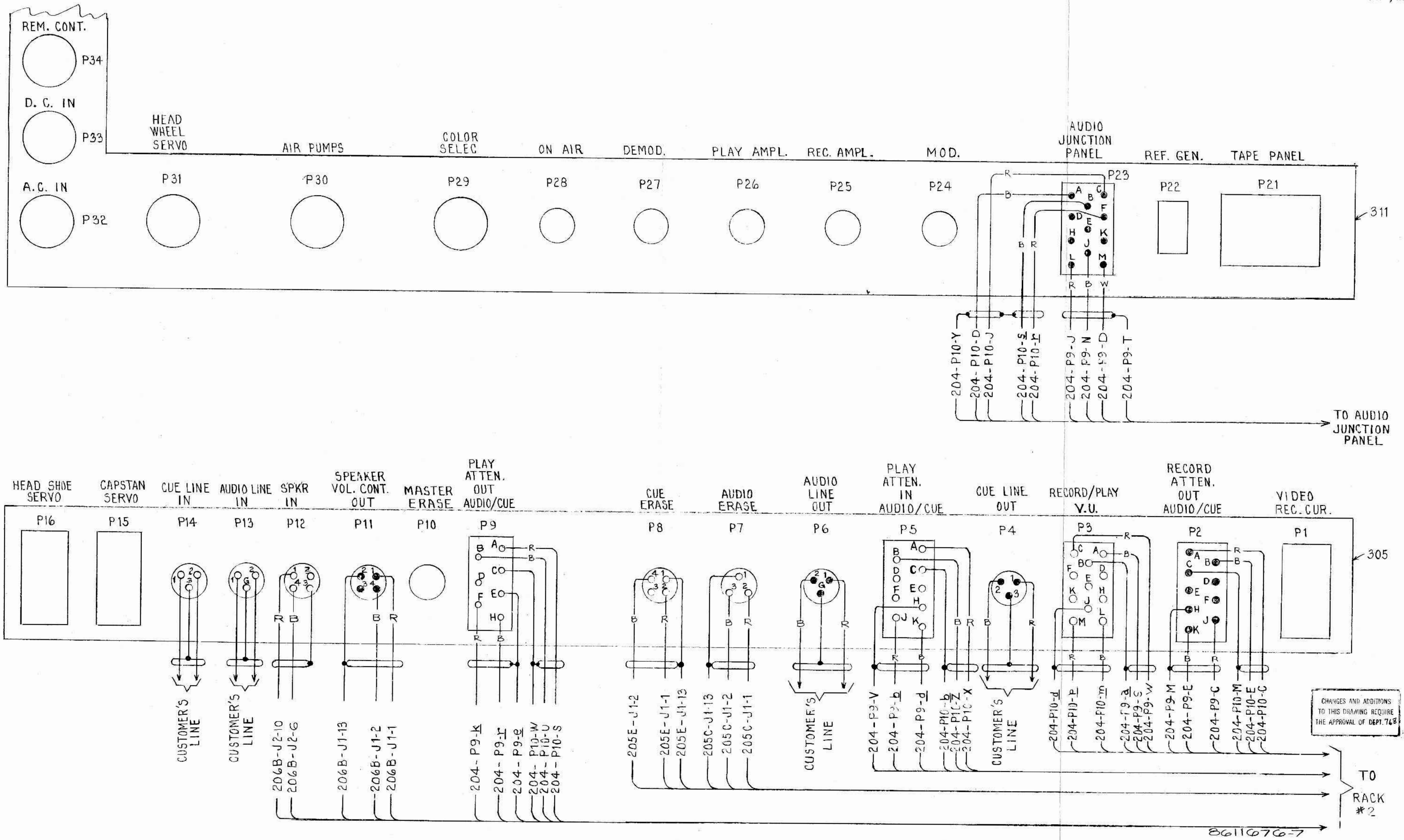


Figure IN-9. Control Functional Diagram



NOTES

1- UNDERSCORED LETTERS ARE LOWER CASE, i.e. s
2- TWISTED PAIR SHIELDED 8978C83-5
3- TWISTED 3 CONDUCTOR SHIELDED 8978083-2.
4 - B=BLACK, W=WHITE & R=RED.

Figure IN-10. Wiring Diagram, Control Panel and Relay Bank

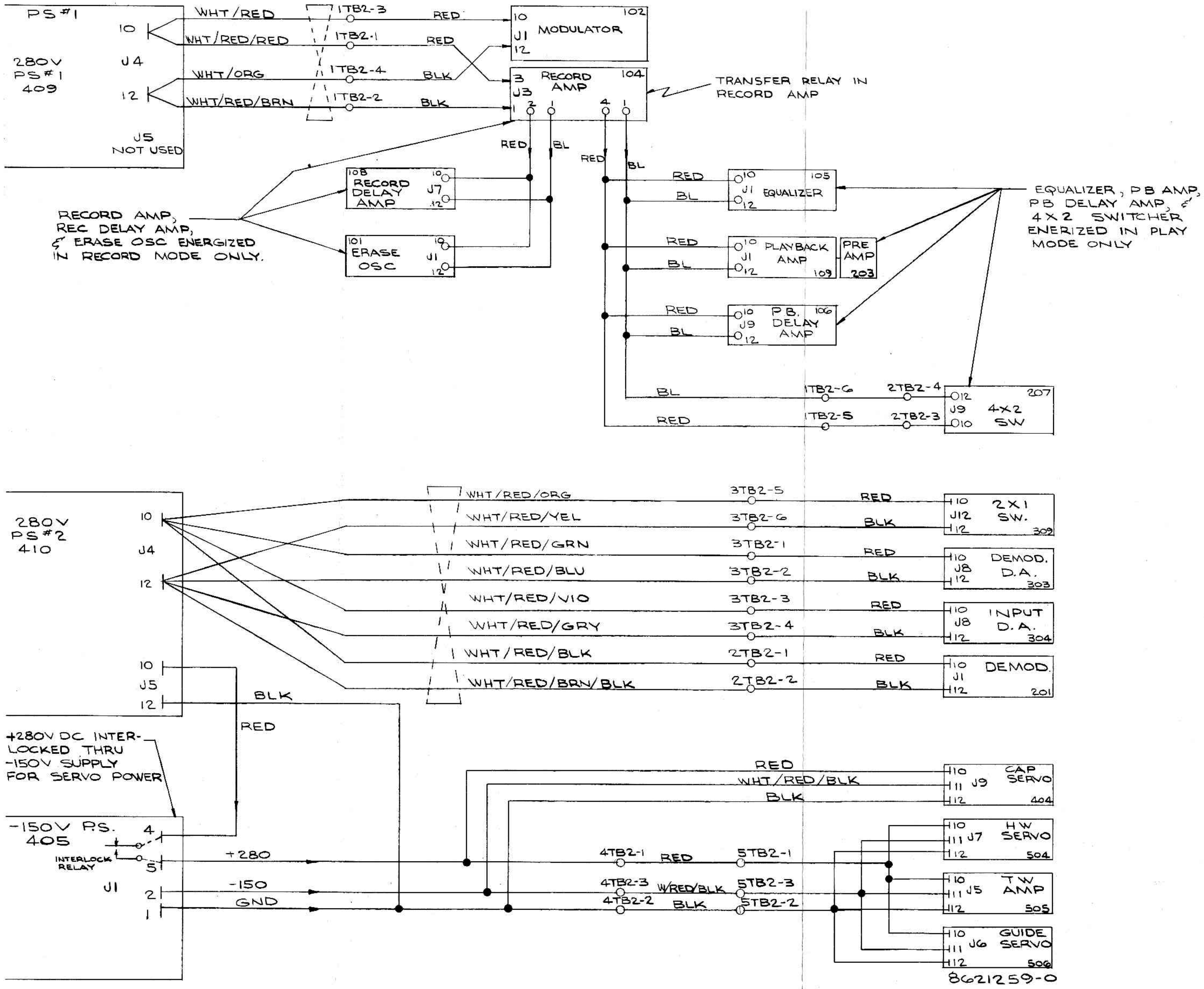


Figure IN-11. DC Power Distribution

ELECTRONIC RECORDING PRODUCTS

RCA

Instructions

RADIO CORPORATION OF AMERICA, Industrial Electronic Products

Operation Manual
for
TRT-1B Television Tape Recorder

IB-31179

Tmk(s) ®

OPERATION MANUAL

FOR

TRT-1B Television Tape Recorder

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
GO 681

IB-31179

FIRST AID

WARNING

OPERATION OF ELECTRONIC EQUIPMENT INVOLVES THE USE OF HIGH VOLTAGES WHICH ARE DANGEROUS TO LIFE. OPERATING PERSONNEL MUST AT ALL TIMES OBSERVE ALL SAFETY REGULATIONS. DO NOT CHANGE TUBES OR MAKE ADJUSTMENTS INSIDE THE EQUIPMENT WITH VOLTAGE SUPPLY ON. UNDER CERTAIN CONDITIONS DANGEROUS POTENTIALS MAY EXIST IN CIRCUITS WITH POWER CONTROLS IN THE OFF POSITION DUE TO CHARGES RETAINED BY CAPACITORS, ETC. TO AVOID CASUALTIES, ALWAYS DISCHARGE AND GROUND CIRCUITS PRIOR TO TOUCHING THEM.

Personnel engaged in the installation, operation and maintenance of this equipment or similar equipment are urged to become familiar with the following rules both in theory and in the practical application thereof. It is the duty of every radioman to be prepared to give adequate First Aid and thereby prevent avoidable loss of life.

ARTIFICIAL RESPIRATION

(Courtesy of the American Red Cross)

If victim is not breathing, begin some form of artificial respiration at once. Wipe out quickly any foreign matter visible in the mouth, using your fingers or a cloth wrapped around your fingers.

MOUTH-TO-MOUTH (MOUTH-TO-NOSE) METHOD

Fig. 1

Tilt victim's head back. (Fig. 1). Pull or push the jaw into a jutting-out position. (Fig. 2).

Fig. 2

If victim is a small child, place your mouth tightly over his mouth and nose and blow gently into his lungs about 20 times a minute. If victim is an adult (see Fig. 3), cover the mouth with your mouth, pinch his nostrils shut, and blow vigorously about 12 times a minute.

Fig. 3

If unable to get air into lungs of victim, and if head and jaw positions are correct, suspect foreign matter in throat, To remove it, place victim in position shown in Fig. 4, and slap sharply between shoulder blades.

Fig. 4

Rescuers who cannot, or will not, use mouth-to-mouth or mouth-to-nose technique should use a manual method.

THE BACK PRESSURE-ARM LIFT (HOLGER-NIELSEN) METHOD

Place victim face-down, bend his elbows and place his hands one upon the other, turn his head slightly to one side and extend it as far as possible, making sure that the chin is jutting out. Kneel at the head of the victim. Place your hands on the flat of the victim's back so that the palms lie just below an imaginary line running between the armpits (Fig. 5).

Fig. 5

Rock forward until the arms are approximately vertical and allow the weight of the upper part of your body to exert steady, even pressure downward upon the hands (Fig. 6).

Fig. 6

Immediately draw his arms upward and toward you, applying enough lift to feel resistance and tension at his shoulders (Fig. 7). Then lower the arms to the ground. Repeat this cycle about 12 times per minute, checking the mouth frequently for obstruction.

Fig. 7

If a second rescuer is available, have him hold the victim's head so that the jaw continues to jut out (Fig. 8). The helper should be alert to detect any stomach contents in the mouth and keep the mouth as clean as possible at all times.

Fig. 8

RELATED INFORMATION FOR BOTH METHODS

If vomiting occurs, quickly turn the victim on his side, wipe out his mouth, and then reposition him.

When a victim is revived, keep him as quiet as possible until he is breathing regularly. Keep him from becoming chilled and otherwise treat him for shock. Continue artificial respiration until the victim begins to breathe for himself or a physician pronounces him dead or he appears to be dead beyond any doubt.

Because respiratory and other disturbances may develop as an aftermath, a doctor's care is necessary during the recovery period.

BURNS

FIRST DEGREE BURN

SKIN REDDENED. Temporary treatment—Apply baking soda or Unguentine.

SECOND DEGREE BURN

SKIN BLISTERED. Temporary treatment — Apply baking sode, wet compress, white petroleum jelly, foille jelly, olive oil, or tea.

THIRD DEGREE BURN

FLESH CHARRED. Temporary treatment — Apply baking soda, wet compress, white petroleum jelly, or foille spray. Treat for severe shock.

PREFACE

This manual contains recommended procedures for operators of the RCA TRT-1B TV Tape Recorder. No description or theory is included. However, three system drawings, the *Rack Layout Diagram, Video Functional Diagram, Monochrome,* and *Video Functional Diagram, Color* are provided for reference at the back of the book.

NOTE: For a functional description of the tape recorder refer to the separate book entitled *Description, TRT-1B TV Tape Recorder.*

Each RCA TV Tape Recorder is equipped with a CRO and a monochrome 17-inch picture monitor. For monochrome, no additional test equipment should be required. For color, an RCA TM-21 Color Monitor, which is not part of the tape recorder, is also required.

Before each recording or playback for air, the *Cleaning Procedures* in Section II-A and either the *Monochrome Setup* or *Color Setup* in Section II-B should be followed. Then specific checks for the desired operation (recording or playback) should be made as in Section II-C. When results indicate that alignment is required the appropriate adjustment should be performed as directed in Section IV-A.

If any performance requirement given in this manual cannot be met, adjustments or repairs should be made as directed in the unit instruction books or System Maintenance Manual.

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LIST OF ILLUSTRATIONS

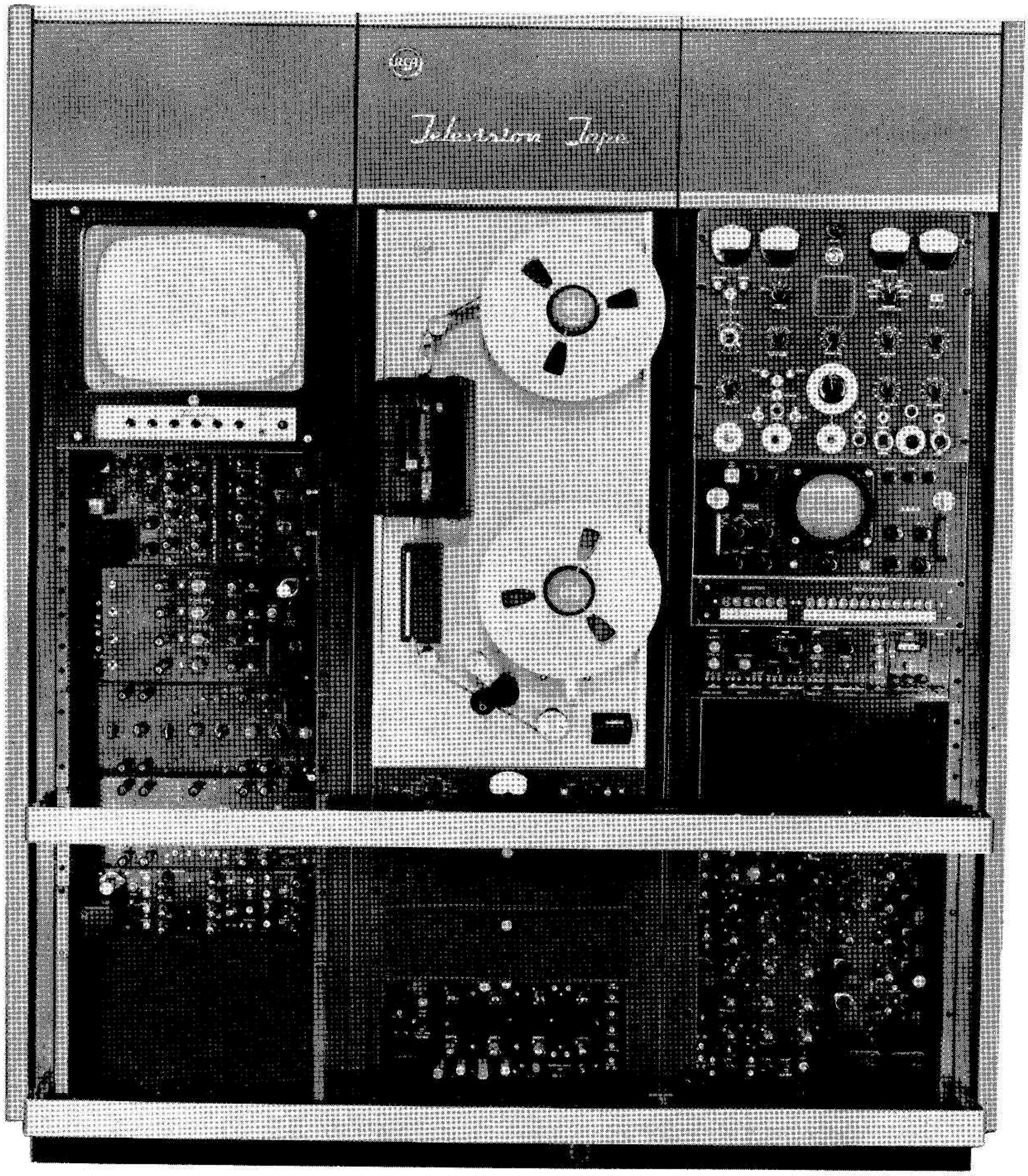

Figure 1—Operations Center, TRT-1B TV Tape Recorder

SECTION I
GENERAL INFORMATION

This section briefly describes the operations which can be performed with the TRT-1B TV Tape Recorder and provides general information supplementary to the procedures given in later sections.

Operating Modes

The following table describes the operating modes which can be selected by pressing the buttons on the control panel.

OPERATING MODES

Mode	*Buttons Pressed*	*Description*
	MAIN MODES	
MASTER RECORD	RECORD	Records on all tracks (video, audio, cue, and control). Permits monitoring audio and control tracks via simultaneous playback heads. Permits monitoring video signal and picture via direct (back-to-back) connection between modulator and demodulator.
PLAYBACK	PLAY	Plays back all tracks.
WIND	WIND	Permits winding tape in either direction at desired speed by use of continuous FORWARD-REVERSE control.*
STOP	STOP	Stops all activity but does not remove power from filaments or power supplies.*
	AUXILIARY MODES	
AUDIO RECORD**	AUDIO RECORD	Records signal on audio track only while playing back all other tracks.
CUE RECORD**	CUE RECORD	Records on cue track only while playing back all other tracks.
SETUP	SETUP	Places machine in MASTER RECORD mode without tape motion to permit adjustments.
STANDBY	STANDBY	Places machine in PLAYBACK mode without tape motion. Used for preliminary servo adjustments. Also permits fast entry into playback mode.*
	RF COPY MODES (Used only when two machines are interconnected for making rf copies)	
RF COPY—SETUP‡	RF COPY† and SETUP buttons on master machine. RF COPY button only, on slave machine.	Feeds rf output of modulator in master machine to rf copy input of slave machine. Used only for monitoring and adjustment of rf levels before making copies.
RF COPY‡	RF COPY† and PLAY buttons on master. RF COPY and RECORD buttons on slave.	On slave machine, records rf copy of tape being played back on master machine.

* When machine is in STOP, STANDBY, or WIND modes and NORMAL-MOD-DEMOD switch is in MOD-DEMOD position both the modulator and demodulator are energized and connected to permit monitoring and adjustments. In other modes the NORMAL-MOD-DEMOD switch has no effect.

** Machine can be in both AUDIO RECORD and CUE RECORD modes. Either mode can then be released separately by pressing release button above corresponding mode selector button.

† RF COPY circuit can be released either by pressing release button above RF COPY button, or placing machine in STOP or WIND modes.

‡ The names of these modes refer to the overall condition of the two machines considered as a unit.

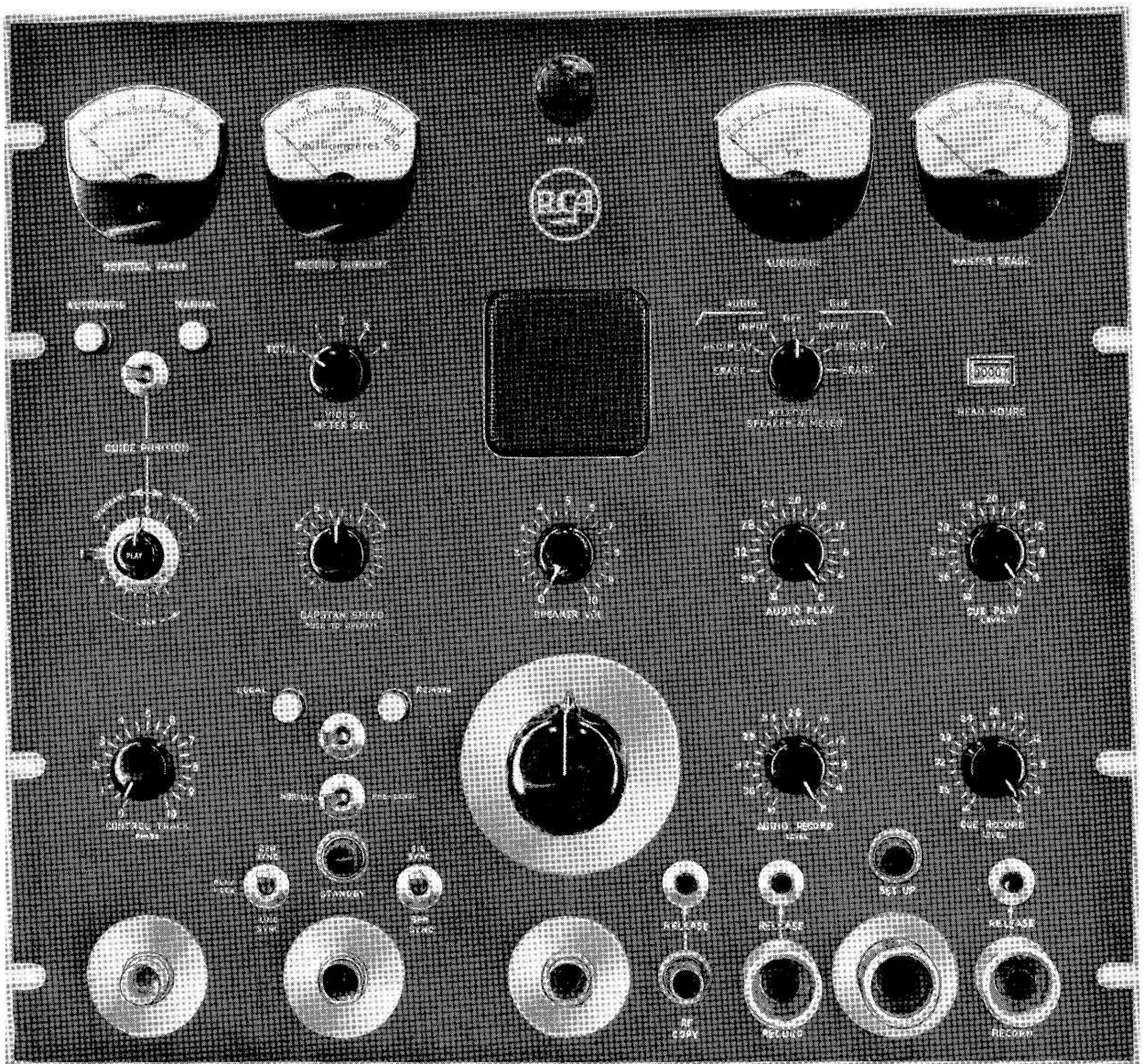

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Figure 2—Closeup of Control Panel

Mode Switching Restrictions

In general, it is possible to switch from a given mode to any other mode except for a few restrictions which prevent damage to the tape or the machine (such as switching directly from the WIND mode to the RECORD or PLAY modes). These restrictions are imposed automatically by electrical interlocking and are listed in the following table.

NOTE: Any mode can be entered if the STOP button is pressed first.

MODE SWITCHING RESTRICTIONS

Mode	*Cannot Be Switched Directly To*
PLAY, or any RECORD mode	SETUP or STANDBY
STANDBY	MASTER RECORD or SETUP
WIND	Any mode but STOP
RF COPY	STANDBY
MASTER RECORD	AUDIO or CUE RECORD

Remote Control

If a remote control panel (MI-40716D) is connected to the recorder the machine can be operated from the remote panel whenever the REMOTE-LOCAL switch on the local control panel in rack 3 is placed in the REMOTE position. The STOP, PLAY, and RECORD modes on the remote panel are identical to those on the local panel but the WIND mode of the local panel is replaced by the FAST FORWARD and FAST REVERSE modes.

NOTE: Connections are provided on the tape recorder for remote control of additional modes not obtainable on the remote control panel.

Choice of Monochrome or Color Standards

To permit choice of standards two switches are provided: the CHROME-MONO switch on the modulator unit and the COLOR-VAR-MONO switch on the demodulator. During recording both switches must be in corresponding positions (for either color or monochrome). During playback, the demodulator switch must be in the position corresponding to the standard used when the recording was made.

The VAR position of the demodulator switch is used only when playing back a monochrome tape recorded with non-standard pre-emphasis. When the switch is in this position, the VAR-DE-EMP control on the demodulator permits adjusting the de-emphasis as required.

NOTE: For normal color operation of a recorder equipped with an accessory color rack, the TEST-OPERATE switch on the burst oscillator unit must be in the OPERATE position. The TEST position is usually used only to permit maintenance on the color rack while the rest of the machine operates on monochrome. This position does not affect the standards selected by the switches on the modulator and demodulator but causes color tape to be reproduced in monochrome (no burst).

Choice of Reference Sync

Two switches on the control panel (RECORD LOCK and PLAY LOCK) permit selection of the main timing source for locking the servo systems of the tape recorder. In the RECORD or SETUP modes the RECORD LOCK switch permits selection of either separated sync derived from the incoming video signal (SIG SYNC position) or local sync (GEN SYNC position). In the PLAYBACK or STANDBY modes the PLAY LOCK switch permits selection of either local sync (GEN SYNC position) or the power line (LINE SYNC). Normally, both switches are kept in the GEN SYNC position.

Manual or Automatic Operation of Vacuum Guide

A toggle switch marked GUIDE POSITION, on the control panel, permits choice of manual or automatic operation of the vacuum guide in the PLAYBACK mode. Normally, the switch is kept in the AUTOMATIC position. However, during adjustments, the switch may be placed in the MANUAL position. The PLAY GUIDE POSITION control (outer knob) directly beneath the switch then becomes effective and may be used to adjust the position of the vacuum guide to obtain desired pressure, or to eliminate jogs in the picture.

Two white lamps are provided to indicate whether the guide is in manual or automatic operation. When the switch is on AUTOMATIC, normally only the AUTOMATIC lamp lights. However, occasionally, when playing back a tape, both lamps may light for a short time. This indicates that a relay circuit has temporarily switched the vacuum guide servo to manual operation to improve reliability.

NOTE: In the RECORD mode the MANUAL-AUTOMATIC switch has no effect and the guide position is determined by the setting of the inner knob of the GUIDE POSITION control. This knob is normally set at zero and locked in position.

Use of Microphone Plugged Into Audio Panel

To permit recording on either the audio or cue tracks by use of the microphone supplied with the tape recorder a microphone jack (MIC IN), a selector

switch (MIC INPUT SEL) and an attenuator (MIC ATTEN) are provided on the audio panel (Unit 204) in rack 2. For normal recording by use of the incoming audio and cue lines the MIC INPUT SEL switch is kept in the OFF position. For recording with the microphone the switch is placed in either the AUDIO or CUE position, as desired, and the MIC ATTEN control is adjusted so that the VU meter on the control panel in rack 3 reads 0 at the peaks. Two red indicator lamps are provided adjacent to the AUDIO and CUE positions of the selector switch. When the switch is in either of these positions the corresponding lamp flashes to indicate that the incoming audio or cue line is cut off.

IMPORTANT: When the microphone is not in use make certain that the MIC INPUT SEL switch is in the OFF position (both red lamps off). If this is not done the information coming over the audio or cue lines will not be recorded.

Tape Handling

Magnetic properties of video tape are stable for years unless altered by strong magnetic fields. If unsatisfactory recordings are obtained a frequent cause is poor head-to-tape contact. This may be due to improper tape handling, heads that are not clean, or distortion of the tape base material. For uniform high quality results observe the following precautions:

1. Keep tape away from strong magnetic fields. Permanent magnets and strong electromagnets can cause erasure if placed within a few inches of the tape.

2. Do not leave tapes exposed when they are not in use. Tapes should be wound on reels and stored in a dust-proof polyethylene bag which is put back in the original box. To prevent damaging the reels store the boxes on end.

3. When tapes is handled, as during splicing, clean white gloves should be worn. During loading and unloading of the recorder, gloves are not essential but are generally recommended.

4. Keep the heads, guides, and other items in the tape path clean. (See *Cleaning Procedures* in Section II).

5. Record and play back tapes in the same range of ambient temperatures. Do not use direct heat such as lamps to warm up a tape.

Tape Splicing

To permit making splices without danger of rollover during playback, the correct places to cut the tape are indicated by 30-cycle frame pulses recorded at ½-inch intervals on the control track. To make these pulses visible a carbonyl-iron suspension such as *VisiMag* must be applied to the tape before making the cut. Because of the time relations between the servo systems and sync, vertical sync is always recorded on track number 1, and the frame pulses are recorded between tracks 3 and 4.

For making splices, the MI-40772 Magnetic Tape Splicer is recommended. Instructions for use are supplied with the splicer.

Tape Threading

The tape threading path is shown in the photograph, figure 3. To install a reel of tape proceed as follows:

1. Press STOP button. Turn the knob of the lower reel hub counterclockwise until it stops, and place an empty reel on the hub. Turn the hub knob clockwise until the pawls engage and the reel is fastened securely against the rear flange.

2. Install the reel of tape on the upper hub as in step 1. Step on the foot switch to release the reel brakes and thread the tape as follows:

a. Pass the tape under the upper tension arm, over the upper air guide, past the master erase head. Open headwheel panel cover and then insert the tape between the headwheel and vacuum guide.

b. Insert the tape in the slot of the audio head compartment. It is not necessary to open the door of the compartment.

c. Pass the tape between the capstan and pressure roller, around the tape timer capstan and over the lower tension arm.

d. Wind one or two feet on the lower reel by turning lower reel counterclockwise, by hand. Then continue turning the reel until the slack is taken up and tension is applied to both the lower and upper tension arms.

NOTE: The brake-release foot-switch plugs into a receptacle in the base of the rack assembly at the bottom of rack 2. The switch is inoperative when the machine is in either the RECORD or PLAYBACK modes.

SECTION II
ROUTINE OPERATING PROCEDURE

A. CLEANING PROCEDURES

For proper operation of the tape recorder all parts of the machine along the tape path must be kept clean. Among the defects that can be caused by dirt or by an accumulation of oxide from the tape coating are:

1. Drop-outs (white flashes) in the picture which may be due to oxide between the heads.

2. Dots occurring at a 960-cycle rate, due to tape scratches.

3. Scallops in the picture, due to lack of concentricity between the tape and the headwheel (caused by oxide in the vacuum guide).

4. Poor tracking due to tape slippage on the capstan.

To keep the equipment clean, the procedures given in the following paragraphs should be performed before each recording or playback for air.

Equipment Required

The following equipment is required during the cleaning procedure:

1. Lint-free tissues.

2. Solvent such as *Freon T.F.*

3. Cleaning tool for air holes in the air guides (MI-40769A, Item 15).

Instead of the recommended Freon T.F., *Chlorothene* (available from any chemical supply agency) may be used. However, use of Chlorothene will soften the oxide binder of the tape. Freon T.F. solvent can be purchased from:

John B. Moore Corporation
Peerless Building
P.O. Box No. 3
Nutley, New Jersey

Cleaning Tape Transport Panel

Clean the following items on the Tape Transport Panel with a lint-free tissue moistened with the solvent. (See figure 3 for location of items.)

1. Upper tension arm
2. Upper air guides
3. Master erase head
4. Audio heads (open door to reach heads)
5. Lower air guide
6. Capstan
7. Capstan pinch roller
8. Counting roller
9. Lower tension arm

Check the upper and lower air guides daily to make certain that the air holes are clean. To do this press the SETUP button on the Control Panel *(with no tape in the machine)* and check each hole for escaping air. If a hole is clogged clean it by inserting the wire end of the air-hole cleaning tool in the hole. Take care to avoid scratching the tape supporting surfaces.

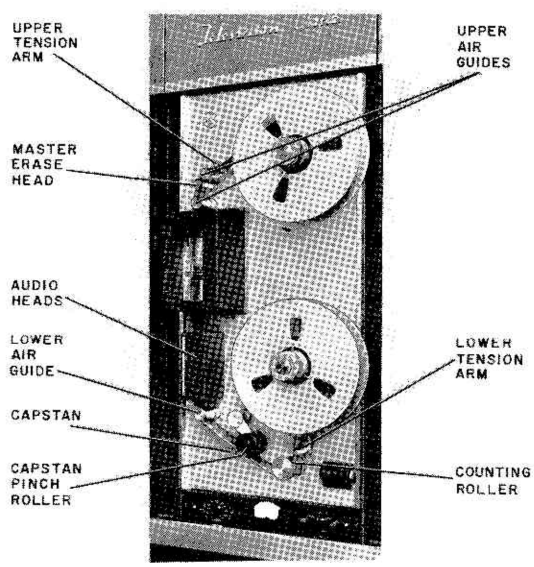


Figure 3—Tape Transport Panel

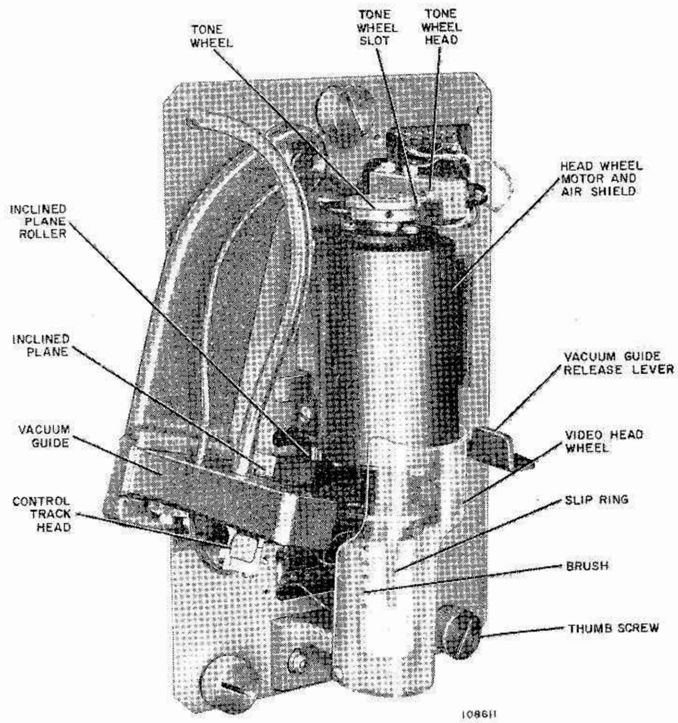


Figure 4—Headwheel Panel, Vacuum Guide Open

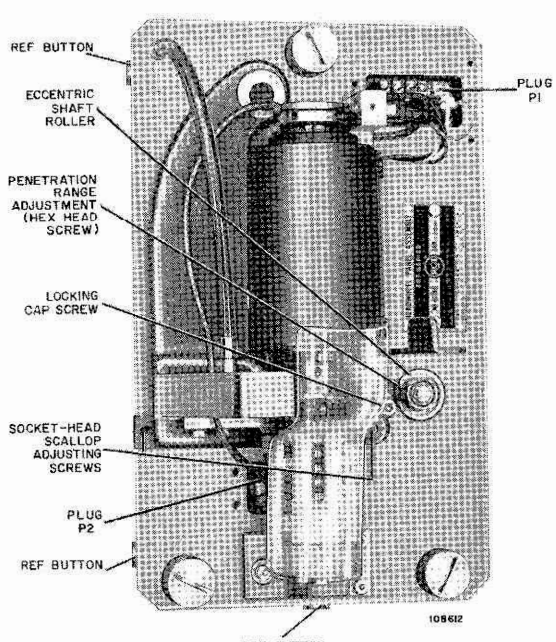


Figure 5—Headwheel Panel, Vacuum Guide Closed

Cleaning Headwheel Panel

Since cleanliness of the video heads and vacuum guide is particularly important, give special attention to cleaning these parts as directed in the following procedure. (See figures 4 and 5 for identification of parts.)

1. Turn the two captive screws in the protective cover of the headwheel panel in a counterclockwise direction and pull the cover forward until it comes off.

2. Open the vacuum guide by pressing the vacuum guide release lever to the right, and at the same time pushing the vacuum guide to the left until it pivots upward.

3. Hold the lint-free tissue saturated with the solvent (Freon or Chlorothene) on the headwheel, and rotate the headwheel by turning the tone wheel by hand.

4. Clean the vacuum guide by wiping the face with a lint-free tissue saturated with the solvent until all dirt and oxide accumulations are removed. Take care to protect the tape-supporting surfaces from scratches. Make sure that the vacuum passages in the vacuum guide are clear.

5. Clean inclined plane roller (see figure 4).

6. Press the vacuum guide release lever to the right, and while holding it in this position, swing the vacuum guide back to its original position.

7. Clean eccentric shaft roller. *Do not allow cleaning fluid to enter ball bearing assembly.*

B. INITIAL SETUP PROCEDURES

Before each use of the machine perform either the *Monochrome Setup* or *Color Setup* as required. Each of these procedures applies to both recording and playback. Additional procedures required specifically before either recording or playback are given in Section II-C.

NOTE: The MONITOR and OSCILLOSCOPE pushbutton switches mentioned in the procedure are on the CRO/Monitor Switcher.

Monochrome Setup

1. Feed either a monoscope or window test signal into the tape recorder.

2. Calibrate the CRO with the internal 1-volt calibration signal as follows:

a. Place VIDEO-CAL switch on CRO in the 1.0 position.

b. Turn V GAIN switch to MED position.

c. Adjust V CENT control until calibration pulse is centered on the screen.

d. Adjust V GAIN FINE control until the amplitude of the calibration pulse is 140 I.R.E. units as indicated by the rulings on the graticule.

e. Return VIDEO-CAL switch to MON position.

3. Press OSCILLOSCOPE VID IN button and adjust VIDEO GAIN control on the Input Distribution Amplifier (D.A. no. 1) for a reading of 1.0 volt (140 I.R.E. units) from sync tip to white.

4. Place the machine in STANDBY mode by pressing STANDBY button on Control Panel, and place the PLAY LOCK switch in the GEN SYNC position. Place NORMAL-MOD-DEMOD switch in MOD-DEMOD.

5. Adjust the controls on the Modulator chassis for the correct FM carrier frequencies at the tip of sync and at white level as follows:

a. Turn the rotary switch to the MONO position.

b. Place the toggle switch in the SYNC TIP position.

c. Adjust the slug marked F.M. CAR. FREQ. for maximum deflection on the DEVIATION TEST meter.

d. Place toggle switch in WHITE TIP position and adjust DEVIATION CONTROL for maximum meter reading.

e. Return toggle switch to SYNC TIP position and leave it there during operation.

6. Place the CHROME-MONOCHROME SWITCH on the Demodulator in the MONOCHROME position.

7. Press OSCILLOSCOPE DEMOD button and adjust VIDEO GAIN control on the Demod. Output Distribution Amplifier for 1.0 volt on the CRO (140 I.R.E. units).

8. Press OSCILLOSCOPE LINE OUT button and make the following adjustments on the Processing Amplifier while observing the CRO.

a. *Video Level.* Adjust VID LEVEL control until the peak-to-peak video voltage, not including pedestal and sync, is 100 I.R.E. units.

b. *Black Level.* Adjust PEDESTAL control for proper setup according to individual requirements.

c. *Sync Amplitude.* Adjust SYNC LEVEL control for proper sync amplitude (40 I.R.E. units).

9. Press MONITOR LINE OUT button and make the following tests on the Processing Amplifier while observing the picture monitor:

a. *Stability Test.* Hold down STABILITY TEST button on Vertical Advance Module and rotate STABILITY TEST knob throughout its range. Normally,

the picture should not change. If any effects are visible, maintenance is required on the Vertical Advance Module.

b. *Horizontal Lockup.* Press and release button on Horizontal AFC Module. Normally, horizontal lockup should occur as soon as button is released. If this does not occur hold down the button and rotate the 31.5 KC FREQ. SET screwdriver adjustment until the picture is as nearly stationary as possible.

10. Press OSCILLOSCOPE LINE OUT button and check the video signal on the CRO for normal widths of vertical and horizontal blanking, horizontal sync, and front porch according to individual requirements. If any of these widths are incorrect, maintenance adjustments are required.

Color Setup

1. Apply a color bar test signal having a split field with a 100% white bar to the input of the tape recorder.

2. Calibrate the CRO with the internal 1 volt calibration signal as follows:

a. Place VIDEO-CAL switch on CRO in the 1.0 position.

b. Turn V GAIN switch to MED position.

c. Adjust V CENT control until calibration pulse is centered on the screen.

d. Adjust V GAIN FINE control until the amplitude of the calibration pulse is 140 I.R.E. units as indicated by the rulings on the graticule.

e. Return VIDEO-CAL switch to MON position.

3. Press OSCILLOSCOPE VID IN button and adjust VIDEO GAIN control on the Input Distribution Amplifier for a reading of 1.0 volt (140 I.R.E. units) from sync tip to white.

4. Place the machine in STANDBY mode by pressing STANDBY button on Control Panel, and place the PLAY LOCK switch in the GEN SYNC position. Place NORMAL-MOD.-DEMOD switch in MOD. DEMOD.

5. Adjust the controls on the Modulator chassis for the correct FM carrier frequencies at the tip of sync and at white level as follows:

a. Turn the rotary switch to the CHROME position.

b. Place the toggle switch in the SYNC TIP position.

c. Adjust the slug marked F.M. CAR. FREQ. for maximum deflection on the DEVIATION TEST meter.

d. Place toggle switch in WHITE TIP position and adjust DEVIATION CONTROL for maximum meter reading.

e. Return toggle switch to SYNC TIP position and leave it there during operation.

6. Place the CHROME-MONOCHROME switch on the Demodulator in the CHROME position.

7. Press OSCILLOSCOPE DEMOD button and adjust VIDEO GAIN control on the Demod. Output Distribution amplifier for 1.0 volt on the CRO (140 I.R.E. units).

8. Adjust the MONOCHROME and CHROME GAIN controls on the Chroma Processor as follows:

a. Insert the test probe of the CRO into the VID IN jack on the Input and Blanking Module of the Processing Amplifier in Rack 3. (The signal at this point is the output of the Chroma Processor.) Place VIDEO/CAL switch of oscilloscope in TEST position. Observe the CRO and adjust MONOCHROME GAIN control until the amplitude between the sync tip and the top of the white bar is 140 I.R.E. units.

b. Adjust the CHROME GAIN control of the Chroma Processor until the levels of the chroma signal in the various color bars are normal.

c. Disconnect the test probe from the Processing Amplifier and return the VID/CAL switch of the oscilloscope to the MON position.

9. Press OSCILLOSCOPE LINE OUT button and make the following adjustments on the Processing Amplifier while observing the CRO.

a. *Video Level.* Adjust VID LEVEL control until the peak-to-peak video voltage, not including pedestal and sync, is 100 I.R.E. units.

b. *Black Level.* Adjust PEDESTAL control for proper setup according to individual requirements.

c. *Sync Amplitude.* Adjust SYNC LEVEL control for proper sync amplitude (40 I.R.E. units).

10. Press MONITOR LINE OUT button and make the following tests on the Processing Amplifier while observing the picture monitor:

a. *Stability Test.* Hold down STABILITY TEST button on Vertical Advance Module and rotate STABILITY TEST knob throughout its range. Normally, the picture should not change. If any effects are visible, maintenance is required on the Vertical Advance Module.

b. *Horizontal Lockup.* Press and release button on Horizontal AFC Module. Normally, horizontal lockup should occur as soon as button is released. If this does not occur hold down the button and rotate the 31.5 KC FREQ. SET screwdriver adjustment until the picture is as nearly stationary as possible.

11. Press OSCILLOSCOPE LINE OUT button and check the video signal on the CRO for normal widths of vertical and horizontal blanking, horizontal sync, and front porch according to individual requirements. If any of these widths are incorrect, maintenance adjustments are required.

12. Adjust BURST control on Processing Amplifier for normal burst level (40 I.R.E. units).

13. On the Color Monitor Switcher press the VID IN button and adjust the phase of the TM-21 Color Monitor while watching color bars on blue screen. To do this proceed as follows:

a. Place the Color Monitor TEST switch on UNITY CHROMA (position 4) and the SCRN SEL switch on B (blue screen).

b. Adjust the BRIGHTNESS control until the areas between the blue bars are just extinguished.

c. Adjust the PHASE control until the four blue bars have equal intensity.

NOTE: Leave the SCRN SEL switch of the color monitor on B (blue screen) until the end of step 17.

14. Press DEMOD OUT button on Color Monitor Switcher and observe the Color Monitor. The appearance of the blue bars should be the same as in step 13C.

15. On the Color Monitor Switcher press COLOR PROC button and adjust the OSC. PHASE control (C-34) on the Burst Oscillator chassis for correct phase while observing blue bars on the TM-21 Color Monitor. (The appearance of the blue bars should be the same as in step 13C.)

16. Press the LINE OUT button on the Color Monitor Switcher and adjust the RECORD PHASE COARSE and FINE controls of the Processing Amplifier in rack 3 for correct phase while observing blue bars on TM-21 Color Monitor.

17. Place the VERTICAL response selector on the CRO in the HP (high-pass filter) position. Press the VID IN button of the OSCILLOSCOPE switch and note the chroma level on the CRO. Press the LINE OUT button of the OSCILLOSCOPE switch and adjust the CHROMA gain control on Color Module of Processing Amplifier for the same level as the VID IN signal. Switch back and forth between the VID IN and LINE OUT buttons to make certain that the two levels are the same. Return the SCRN SEL switch on the TM-21 Color Monitor to the RGB position and stop machine.

18. Load the machine with a color recording. (A standard practice is to record a one-minute interval of color bars at the beginning of each color recording to permit an accurate adjustment of the Four-Channel Equalizer.)

19. Play back the color bar section of the color tape and make the following adjustments:

a. Press LINE OUT button on Color Monitor Switcher and adjust the HF COMP-CH-1, CH-2, CH-3, and CH-4 controls on the Four-Channel Equalizer chassis until no bands are visible in the red bar.

b. Press 2 X 1 OUT button of OSCILLOSCOPE switch and adjust the GAIN CH-1, CH-2, CH-3, and CH-4 controls on the Playback Delay Amplifier for equal levels (100 I.R.E. units).

c. Press DEMOD OUT button on OSCILLOSCOPE switch and place the response selector switch on the oscilloscope in the HP position. Adjust the H. FREQ. COMP. control on the 2 X 1 Switcher for normal chroma level on the CRO.

d. Press LINE OUT button on Color Monitor Switcher and turn the SCRN SEL switch of the Color Monitor to B. Then adjust the PLBK PHASE control on the Processing Amplifier while observing blue bars on the Color Monitor.

NOTE: If indications of poor signal-to-noise ratio or poor head matching (particularly reddish and greenish bands in the yellow bar) are obtained during playback of the test recording, perform the *Video Head Optimization for Color* procedure given in the individual instruction book for the Headwheel Panel, Unit 200-A.

C. FINAL CHECKS

Before each recording or playback for air make certain that the recorder has been cleaned according to Section II-A and that the initial setup procedure for either monochrome or color, as required, has been performed according to Section II-B. Then complete the procedure by making the checks corresponding to the desired operation given in the following paragraphs.

Checks Before Recording

1. Check the Vacuum Guide position and pole-tip penetration by playing back the RCA Vertical Bar Alignment Tape (MI-40771-B) as directed in Section IV-A, *Vacuum Guide Position Adjustments,* steps 1 and 2. If necessary, touch up the adjustments as directed in steps 3 and 4 of the same procedure. Then remove the alignment tape from the recorder.

CAUTION: Do not place the machine in the SETUP or RECORD modes while the alignment tape is threaded, or portions of the tape will be erased.

2. Load tape to be used for recording on the tape transport panel. Then *double check the tape threading.*

3. Place REC LOCK switch in SIG SYNC position and place machine in SETUP.

4. Check the head-current meters on Control Panel for the following indications:

a. CONTROL TRACK meter should read optimum current determined during the *Control Track Head Optimization* procedure given in Section IV-B (approximately 3.5).

b. RECORD CURRENT meter should read optimum values found during optimization of the Headwheel Panel being used.

c. MASTER ERASE meter should read between 0.45 and 0.5.

5. Place the SPEAKER AND METER selector switch in the AUDIO REC/PLAY position and adjust the AUDIO RECORD LEVEL control until the AUDIO/CUE meter peaks at 0 VU on program material.

6. If cue information is to be recorded on the tape, place the SPEAKER AND METER selector switch in the CUE-REC/PLAY position and adjust the CUE RECORD LEVEL control until AUDIO/CUE meter peaks at 0 VU on incoming cue information.

7. Press the corresponding buttons on OSCILLOSCOPE switch and observe the CRO for the following indications:

a. CT REC—Frame pulse superimposed on 240-cycle sine wave.

b. REF PULSE—Negative polarity pulse.

c. TW PULSE—Positive polarity pulse.

d. HW SERVO—Trapezoid with pip on center of every fourth negative slope.

e. CAP SERVO—Sawtooth with pip on center of every fourth positive slope.

NOTE: Typical waveforms on the CRO are shown in figures 14, 15, and 16.

8. Press TW PULSE button on the MONITOR switch and observe the Picture Monitor. Normal motion of the TW dots is from 1/4 inch to 1 inch for an input signal locked to a crystal and up to 10 inches or more for a signal locked to the power line.

9. Take recorder out of SETUP mode by pressing STOP button.

10. Check to see that the LOCAL-REMOTE switch is in the desired position.

11. Place the FORWARD-REVERSE knob on the Control Panel in the FORWARD position. Press the WIND button and wind forward to the point where recording will begin. Press STOP button.

12. Set the TAPE TIMER to zero.

13. Place the recorder in the RECORD mode and record about two minutes of program material as indicated on TAPE TIMER. While making this recording, check the audio level on the AUDIO/CUE meter, and simultaneously listen to the program audio on the Control Panel speaker. Also press CT PB button on MONITOR switch and observe CRO for simultaneous control track playback.

NOTE: On simultaneous audio playback there is a delay of approximately one-tenth of a second between sound and video.

14. On the Control Panel press the WIND button and turn the FORWARD-REVERSE control to the REVERSE position. Allow the tape to rewind until the TAPE TIMER reads zero.

15. Place the Control Panel switch labeled PLAY LOCK in the GEN SYNC position.

16. Press the PLAY button. The information previously recorded can be viewed on the Picture Monitor and heard on the Control Panel speaker.

17. Place the GUIDE POSITION toggle switch in the AUTOMATIC position.

18. Press the 2 X 1 OUT button on the OSCILLOSCOPE switch and observe the composite FM signal of the four heads on the CRO. Adjust the CONTROL TRACK PHASE control on the Control Panel for maximum peak-to-peak signal on the CRO.

NOTE: The information recorded by a particular head can be identified by noting that vertical sync is always recorded by head number 1. The information played back by a particular head can be identified by pressing the shorting buttons on the Four-Channel Equalizer.

19. Touch up the HF COMP CH-1, CH-2, CH-3, and CH-4 controls on the Four-Channel Equalizer for equal high-frequency response.

NOTE: The HF COMP. adjustments should be made for best appearance of the picture. Consequently the results obtained depend on the skill of the operator. For monochrome, the adjustments should be made to obtain maximum resolution of vertical edges without overshoots (indicating excessive high peaking), and to eliminate bands due to unequal response in the four channels. For color, the adjustments should be made primarily to eliminate banding in red areas.

20. Press the 2 X 1 OUT button on OSCILLOSCOPE switch and adjust the GAIN CHAN-1,

CHAN-2, CHAN-3, and CHAN-4 controls on the Playback Delay Amplifier for equal amplitude (approximately 100 I.R.E. units).

21. After the preceding tests are concluded, rewind to the place where the program recording is to begin, stop the machine, and reset the tape timer to zero. The machine is now ready for recording.

Checks During Recording

1. During the recording observe the following meters on the Control Panel and the following waveforms on the CRO for the indications given. (See figures 14, 15, and 16 for typical waveforms.)

a. CONTROL TRACK meter—normal current.

b. RECORD CURRENT meter—normal current.

c. AUDIO/CUE meter—normal level.

d. MASTER ERASE meter—normal current.

e. CT PB waveform—normal waveform indicating presence of simultaneous control track.

f. HW SERVO waveform—lock-in of pip on trapezoid.

g. CAP SERVO waveform—lock-in of pip on sawtooth.

2. After all the desired program information is recorded, press the STOP button.

3. Press the WIND button and turn the FORWARD-REVERSE knob to REVERSE so that the tape will rewind. Allow tape to rewind until the TAPE TIMER returns to zero and then push the STOP button.

NOTE: It is possible to go directly to WIND without going through the STOP position.

4. It is good practice to spot check the recording by playing back the beginning, middle and end.

Checks Before Playback

Load the tape for playback on the Tape Transport Panel and *double check tape threading.* Then play back the recorded tape and sample it near either end and near the center of the tape. During this test playback, check the items in the following table:

CAUTION: NEVER place the recorder in the SETUP mode while a recorded tape is threaded on the transport because the erase heads are activated at this time. If a check of the recorder has to be made in the SETUP mode, unthread the tape.

CHECKS BEFORE PLAYBACK

Adjustments	*Check or Adjust For*
a. CONTROL TRACK PHASE control.	a. Maximum FM output as observed at 2 X 1 OUT on CRO.
b. COLOR-VAR-MONO switch on demodulator.	b. Desired position (MONO, VAR, or COLOR)*
c. GUIDE POSITION toggle switch.	c. Switch in AUTOMATIC position.
d. Four-Channel H.F. COMP controls on Equalizer.	d. Equal high frequency response (see note below step 19 under *Checks Before Recording*).
e. Four-Channel GAIN controls on Playback Delay amplifier.	e. Equal amplitude (100 I.R.E. units) at 2 X 1 OUT on CRO.
f. AUDIO PLAY control on Control Panel and GAIN control on BA-23 Program Amplifier.	f. Turn AUDIO PLAY LEVEL control on Control Panel to +12 and GAIN control of BA-23 Program Amplifier fully clockwise. Then adjust AUDIO PLAY LEVEL control until AUDIO/CUE meter peaks at 0 VU.
g. Processing Amplifier Controls.	g. Proper video, setup and sync levels at LINE OUT on oscilloscope. (For color also check burst phase and chroma levels.)
h. CAPSTAN SPEED control (adjustment required only if a "B" copy machine is used for protection).	h. Synchronization between sound of "B" machine and sound of "A" machine. (Push in CAPSTAN SPEED control of "B" machine and rotate it until sound of two machines is synchronized.)

* To play back a monochrome tape having non-standard pre-emphasis, press DEMOD OUT button on OSCILLOSCOPE switch and observe waveform. Place COLOR-VAR-MONO switch in VAR position and adjust VAR DE-EMP control on demodulator to obtain minimum spikes (overshoots) on blanking or sync.

D. RF COPIES

Facilities are provided in the tape recorder for making rf copies of pre-recorded tapes by recording on one machine (*slave*) the fm output of another machine playing back a tape (*master*). RF copying differs from video copying in that the fm information is not demodulated. Losses due to demodulation and successive re-modulation, are eliminated. However all equipment used in the copying process (such as distribution amplifiers or switchers for making several copies simultaneously) must have good phase and frequency response up to 10 megacycles.

Two machines can be interconnected for making rf copies by connecting the rf copy output of the master machine to the rf copy input of the slave machine.

To make rf copies on two machines which have been properly interconnected proceed as follows:

1. Set up the master machine for normal playback and the slave machine for normal recording as previously directed.

2. On master machine press RF COPY and SETUP buttons.

3. On slave machine press SETUP button, turn the VIDEO METER SEL switch to position 1 and note the reading of the RECORD CURRENT meter for head number 1. Then press RF COPY button. Leave the meter switch on position 1.

4. On demodulator of master machine adjust RF COPY OUT control until head number 1 current of slave machine (with RF COPY button depressed) is the same as previously noted.

5. Thread the pre-recorded tape on the master machine and the tape on which the copy is to be made on the slave machine. Wind both tapes to the desired points.

6. When ready to start recording first press RECORD and RF COPY buttons on slave machine and then press PLAY and RF COPY buttons on master machine. Do not start the master machine first or some information will be lost at the beginning of the recording.

SECTION III
ABBREVIATED OPERATING PROCEDURE

The following abbreviated procedure provides a summary of the detailed procedures in Section II and also serves as a rapid check list for the experienced operator.

INITIAL SETUP

Monochrome

1. Clean headwheel and tape transport panels.
2. Calibrate CRO waveform monitor for 1 volt.
3. Adjust gain of input distribution amplifier.
4. Turn rotary switch on modulator to MONO. Adjust carrier frequency and deviation.
5. Turn rotary switch on demodulator to MONO.
6. Adjust gain of output distribution amplifier.
7. On signal processing amplifier, adjust video, pedestal, and sync and make stability and horizontal lockup tests.

Color

1. Perform steps 1 to 3 of *Monochrome* setup above.
2. Turn rotary switch on modulator to CHROME. Adjust carrier frequency and deviation.
3. Adjust gain of output distribution amplifier.
4. Adjust monochrome and chroma gain controls on chroma processor.
5. On signal processing amplifier, adjust video, pedestal, sync, and burst and make stability and horizontal lockup tests.
6. Adjust phase of TM-21 Color Monitor.
7. Adjust oscillator phase on burst oscillator.
8. Adjust record phase and chroma gain on signal processing amplifier.
9. While playing back a tape pre-recorded with color bars, make the following adjustments:
   a. Four-channel equalizer.
   b. Gain controls on playback delay amplifier.
   c. High-frequency compensation on 2 X 1 switcher.
   d. Playback phase on signal processing amplifier.

FINAL CHECKS

Before Recording

1. Check guide position and pole-tip penetration with test tape.
2. Load tape and double check threading.
3. Check record meters on control panel.
4. Adjust audio and cue record levels on control panel.
5. Check servo waveforms on CRO and tonewheel dots on picture monitor.
6. Make a two-minute test recording. Check audio levels and control track playback waveform.
7. While playing back test recording make the following adjustments:
   a. Control track phase on control panel.
   b. Four-channel equalizer.
   c. Gains on playback delay amplifier.
8. Rewind to start of tape. Set tape timer.

During Recording

Check waveforms and meters during recording. When completed spot check recording by playing back beginning, middle, and end.

Before Playback

Check the following:

1. MONO-VAR-COLOR switch on demodulator. (Adjust VAR-DE-EMP control if required.)
2. Control Track Phase on control panel.
3. GUIDE POSITION switch on control panel (normally on AUTOMATIC).
4. Audio play level on control panel.
5. Controls on signal processing amplifier.
6. Capstan speed adjustment (only if second machine is used for protection).

During Playback

Monitor picture and audio. Observe meters and waveforms for warning of possible trouble.

SECTION IV
NON-ROUTINE ADJUSTMENTS

The following procedures are not part of routine operation but should be performed whenever the checks given in the preceding sections indicate that they are required.

A. ALIGNMENT PROCEDURES

The following procedures permits elimination of scallops and jogs in the picture due to incorrect positioning of the Vacuum Guide, and steps (parallel horizontal displacements) due to deviations of the four heads from exact quadrature (90 degree relationship). The photographs, figures 7 to 12, show playback of an RCA Alignment Tape (MI-40771-B) under conditions producing scallops, jogs, steps, or a normal picture.

Equipment Required

Both the Vacuum Guide and Quadrature Adjustments require use of an RCA MI-40771-B alignment tape. In addition, the Vacuum Guide adjustments require the following wrenches:

a. 3/32-inch socket wrench (MI-40769, Item 9) for scallop adjustment.

b. 1/8-inch socket wrench (MI-40769, Item 8) for jog adjustment. (New standard on screw requires 9/64 inch socket wrench.)

c. 1/4-inch open-end wrench (MI-40769, Item 7) for jog adjustment.

Vacuum Guide Position Adjustments

1. Install the alignment tape, MI-40771-B, on the machine.

> *CAUTION: Do not put the tape recorder in the SETUP or RECORD mode of operation while the alignment tape is threaded since portions of the test tape may be erased.*

2. Put the GUIDE POSITION switch in AUTOMATIC and place the tape recorder in the PLAY mode by pushing the PLAY button. Press the 2 X 1 OUT button on the OSCILLOSCOPE switch and adjust the CONTROL TRACK PHASE knob for maximum output. Then press the LINE OUT button on the MONITOR switch and observe the Picture Monitor.

3. *Scallop Adjustment (Perpendicular Alignment of Vacuum Guide).*

a. Insert the 3/32-inch socket wrench (MI-40679, Item 9) in the socket-head scallop adjustment screw at the left of the vacuum guide (see Figure 6).

b. Turn the screw counterclockwise if the scallops are concave to the right (figure 7) or clockwise if the scallops are concave to the left (figure 8). When all scallops are eliminated the position of the vacuum guide perpendicular to the panel is correct.

4. *Jog Adjustment (Penetration or Parallel Alignment of Vacuum Guide).*

a. Place the GUIDE POSITION switch in MANUAL and set the PLAY GUIDE POSITION knob to 0 on the scale (twelve o'clock position).

b. Using the 1/8-inch socket wrench (MI-40769, Item 8) loosen the locking cap screw on the right hand corner of the vacuum guide arm (see figure 6).

c. With 1/4-inch open-end wrench (MI-40769, Item 7) turn the hex-head screw directly above the locking screw loosened in step b. until all jogs are eliminated. Move wrench upward to increase penetration (figure 9) or downward to decrease penetration (figure 10).

d. To insure an accurate setting open and close the vacuum guide several times by first pressing the PLAY button and then, after the Vacuum Guide closes, pressing the STOP button.

e. Tighten the locking screw loosened in step b. The lines should then appear as in figure 12 (unless steps are present, as in figure 11, indicating that a *Head Quadrature Adjustment* is required).

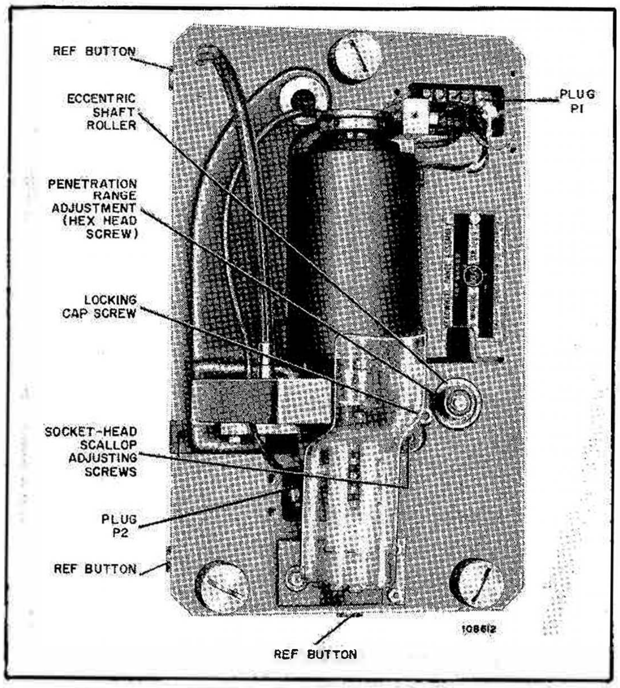


Figure 6—Headwheel Panel Adjustments

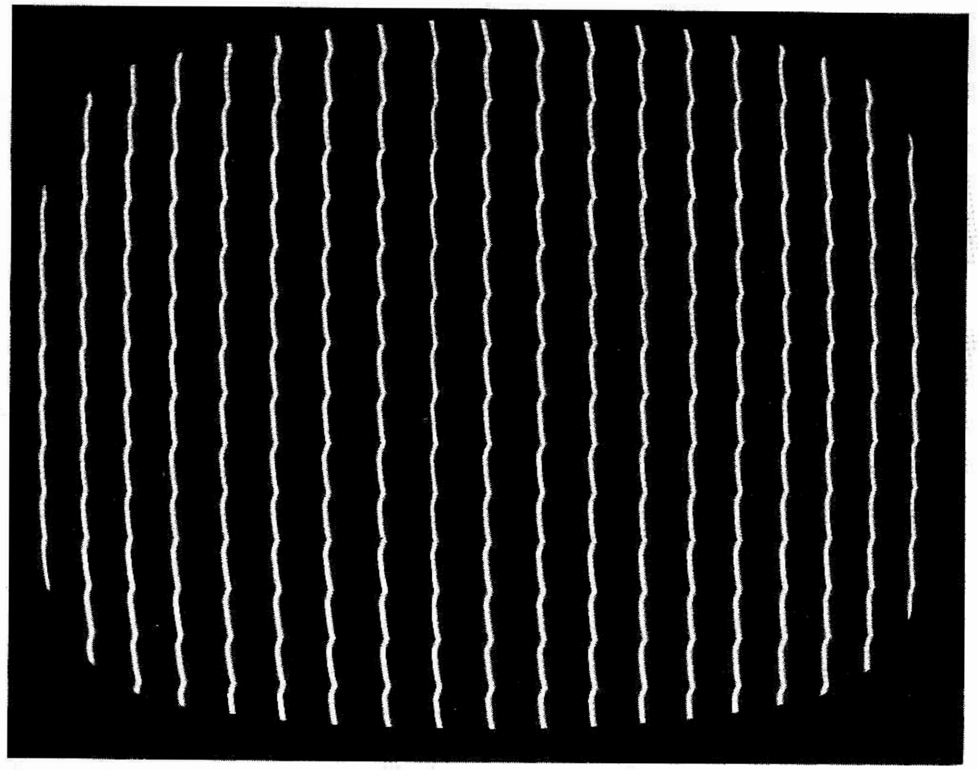


Figure 7—Scallops in Bar Pattern; Vacuum Guide Too Far Out (Turn Screw Counterclockwise to Correct)

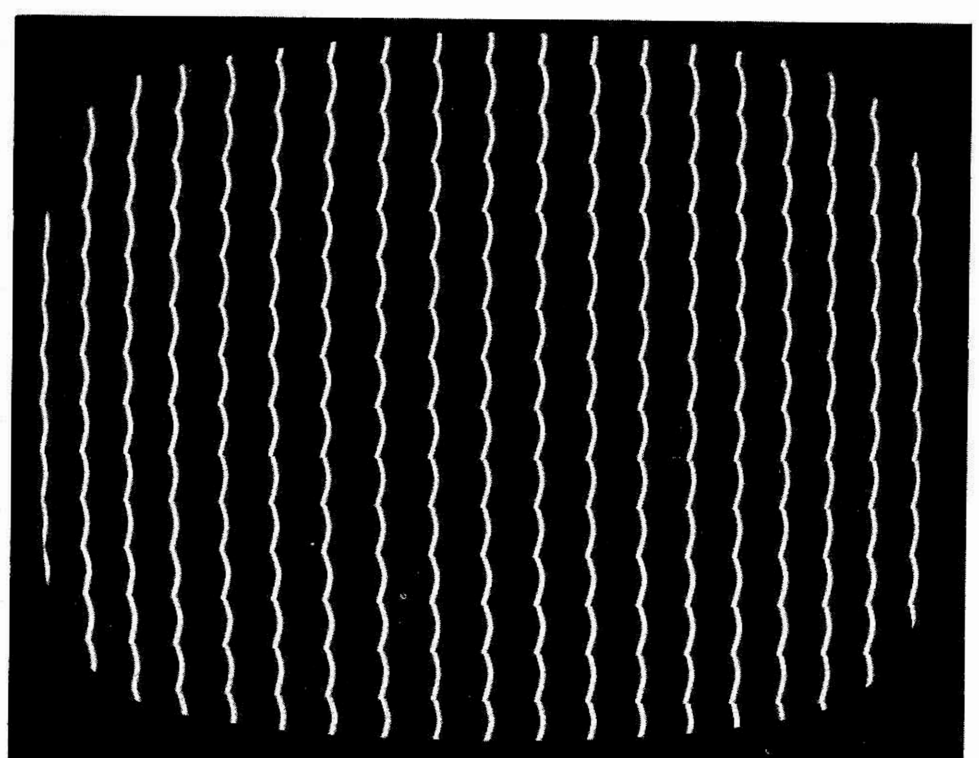


Figure 8—Scallops in Bar Pattern; Vacuum Guide Too Far In (Turn Screw Clockwise to Correct)

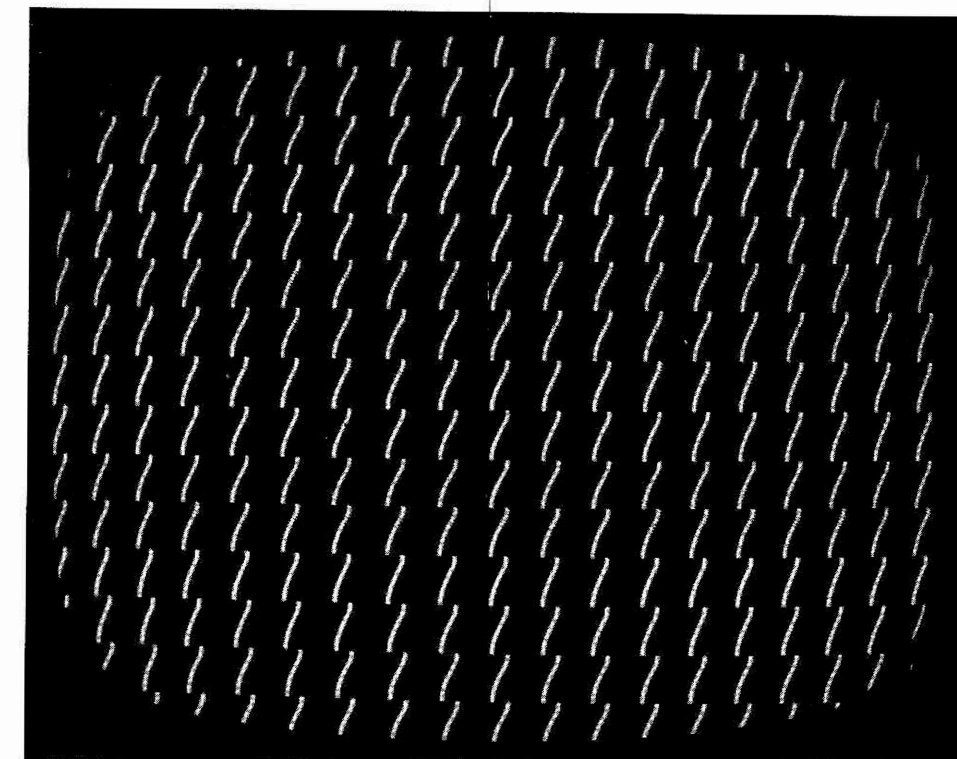


Figure 9—Jogs in Bar Pattern; Insufficient Head Penetration (Move Wrench Up to Correct)

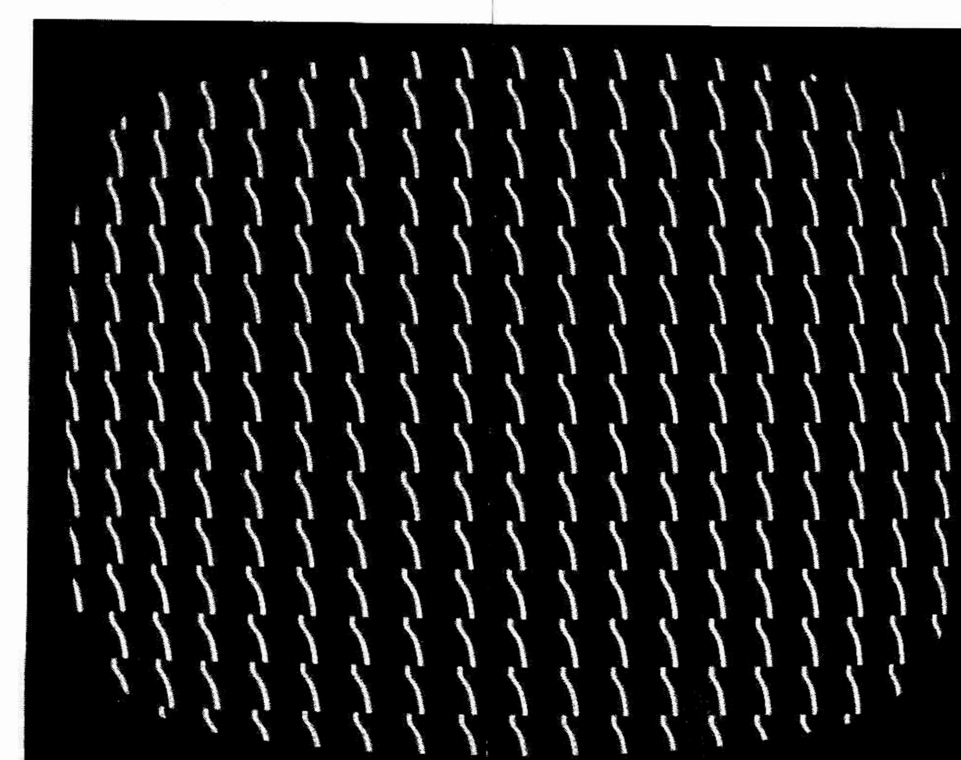


Figure 10—Jogs in Bar Pattern (Excessive Head Penetration) (Move Wrench Down to Correct)

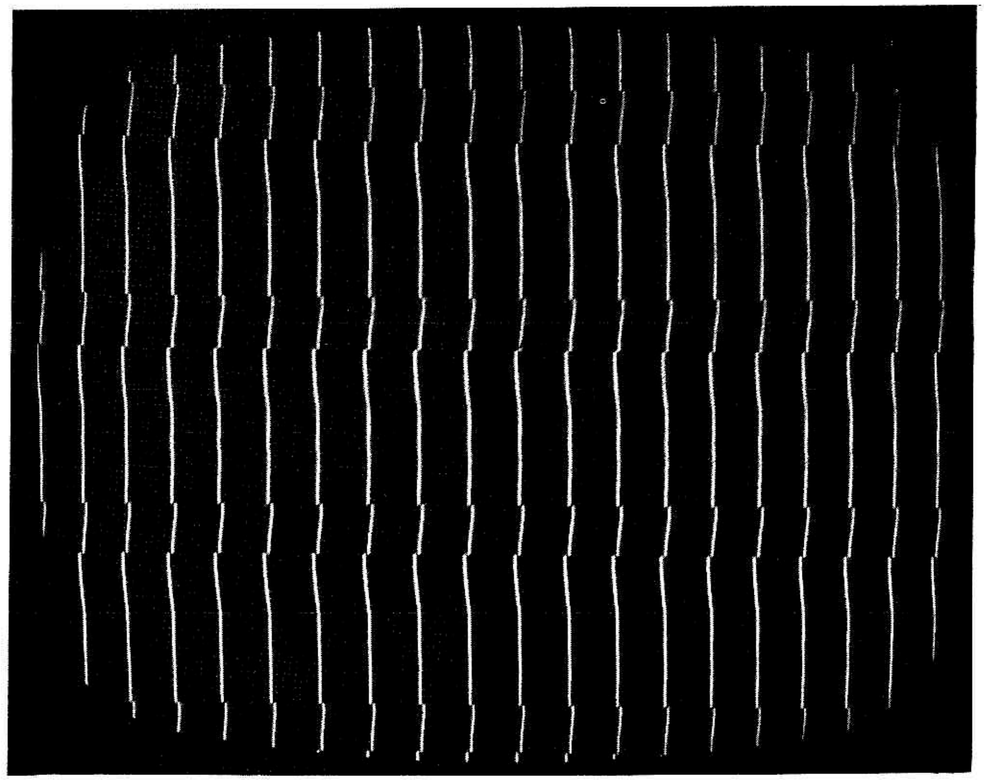


Figure 11—Steps in Bar Pattern (Quadrature Misadjusted)

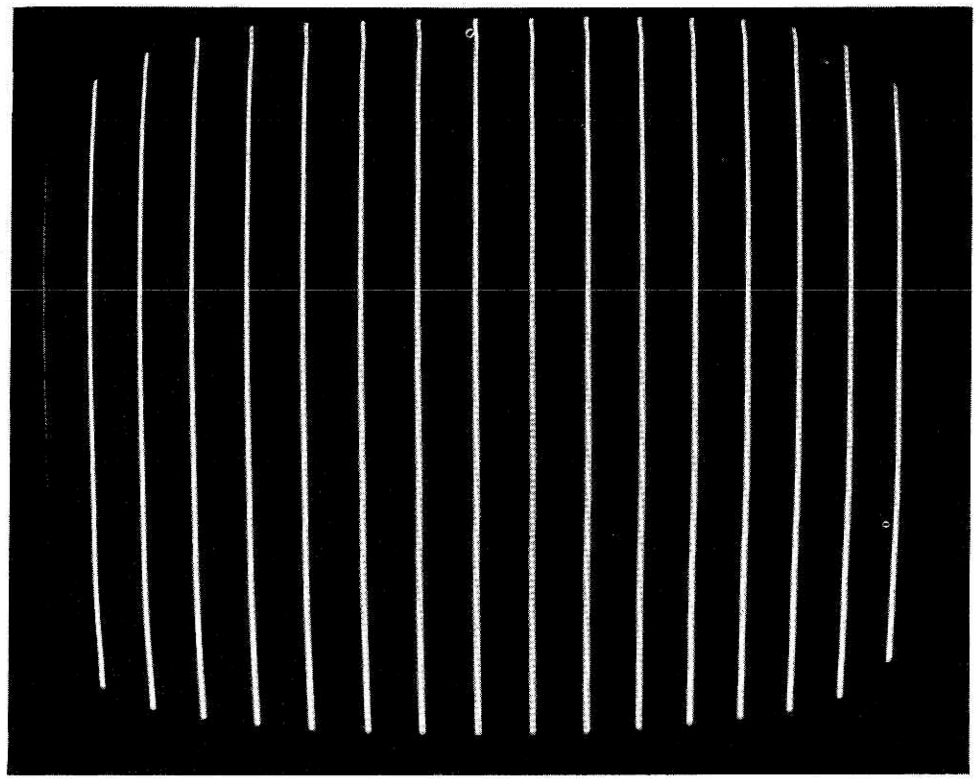


Figure 12—Normal Appearance of Alignment Bars

Tracking of RECORD and PLAY GUIDE POSITION Knobs

Check the tracking of the RECORD and PLAY GUIDE POSITION knobs on the Control Panel as follows:

1. Remove alignment tape from machine.

2. Unlock the GUIDE POSITION RECORD knob, turn it to zero (twelve o'clock position), and lock knob.

3. Load a tape on the machine and record several minutes of material containing vertical lines, to permit checking for jogs.

4. Stop machine, rewind, place GUIDE POSITION switch in MANUAL, and play back recording.

5. Adjust GUIDE POSITION PLAY knob for no jogs in picture. This condition should be obtained when PLAY knob is in zero position; otherwise, maintenance is required.

NOTE: If maintenance operations are performed to correct knob tracking the *Jog Adjustments* (step 4) under *Vacuum Guide Position* Adjustments must be repeated.

Head Quadrature Adjustment

1. Place the GUIDE POSITION switch on the Control Panel in the AUTOMATIC position.

2. Install the MI-40771-B Alignment Tape and place the tape recorder in the PLAY mode.

3. Adjust the CONTROL TRACK PHASE control and the four H.F. COMP. controls on the Equalizer chassis to produce the optimum picture.

4. Set all four DELAY knobs on the Playback Delay Amplifier to zero and observe the picture. The presence of steps in the vertical lines (figure 11) indicates that the heads are not exactly in quadrature (90 degrees apart). Identify the head which produces an average amount of horizontal displacement with respect to the other heads (steps about halfway between the extreme left and the extreme right) and leave the DELAY knob corresponding to that head at zero. Adjust the other three DELAY controls to minimize the horizontal displacements.

NOTE: Since the delay steps are quite small this adjustment must be made with care to insure optimum alignment of the vertical bars. In addition penetration and scalloping adjustments should be retouched to achieve best results.

5. The quadrature relation of the heads is the same for recording or playback except that the relative sense (lag or lead) is reversed. Consequently the DELAY controls on the Record Delay Amplifier should be adjusted as follows:

a. On Playback Delay Amplifier note the channel on which the DELAY control is set to zero. On Record Delay Amplifier set DELAY control on same channel to zero.

b. Turn each of the other three DELAY knobs on the Record Delay Amplifier to the same numeral as that of the corresponding Playback Delay knob, but in the opposite direction from zero. (Refer to following table.)

TYPICAL DELAY SETTINGS

	Channel 1	*Channel 2*	*Channel 3*	*Channel 4*
Playback Delay	+3	0	−1	−2
Record Delay	−3	0	+1	+2

6. Remove the alignment tape from the machine.

7. Record test pattern or other test signal with vertical lines. Playback of this recorded signal should produce vertical lines. In addition, when the CONTROL TRACK PHASE knob is turned to another track position, the vertical lines should contain a minimum of horizontal displacements. Large displacements indicate that the corrections should be rechecked.

B. HEAD OPTIMIZATION

Video Heads

To obtain optimum results during recording, the record currents must be adjusted by turning the four GAIN controls on the Record Amplifier until each of the four heads in the Headwheel Panel just saturates the tape when a normal input signal is applied. Procedures for making these adjustments are given in the unit instruction book for the Headwheel Panel.

Since the optimum currents change with wear, and the heads wear unequally, the procedure will have to be repeated whenever the checks in Section II indicate that new optimum values are required. Some of these indications are:

1. Poor signal-to-noise ratio.

2. Bands of unequal contrast.

3. Bands of varying hue (particularly red and green bands in yellow areas).

Control Track Head

The control track head should be optimized as follows whenever a new Headwheel Panel is installed:

1. Thread tape on recorder.

2. Place machine in RECORD mode.

3. Press CT PB button on OSCILLOSCOPE and observe the simultaneous control track presentation at a 240 cycle rate.

4. On the Capstan Servo chassis adjust the 240 CT REC control until the simultaneous control track signal just begins to show saturation. The correct waveform is shown in figure 13A where saturation is indicated by the slight shoulder in the zero axis of the distorted sine wave. Figures 13B and 13C show under- and over-saturated tape waveforms.

5. Observe the CONTROL TRACK meter and write down the final current for future reference.

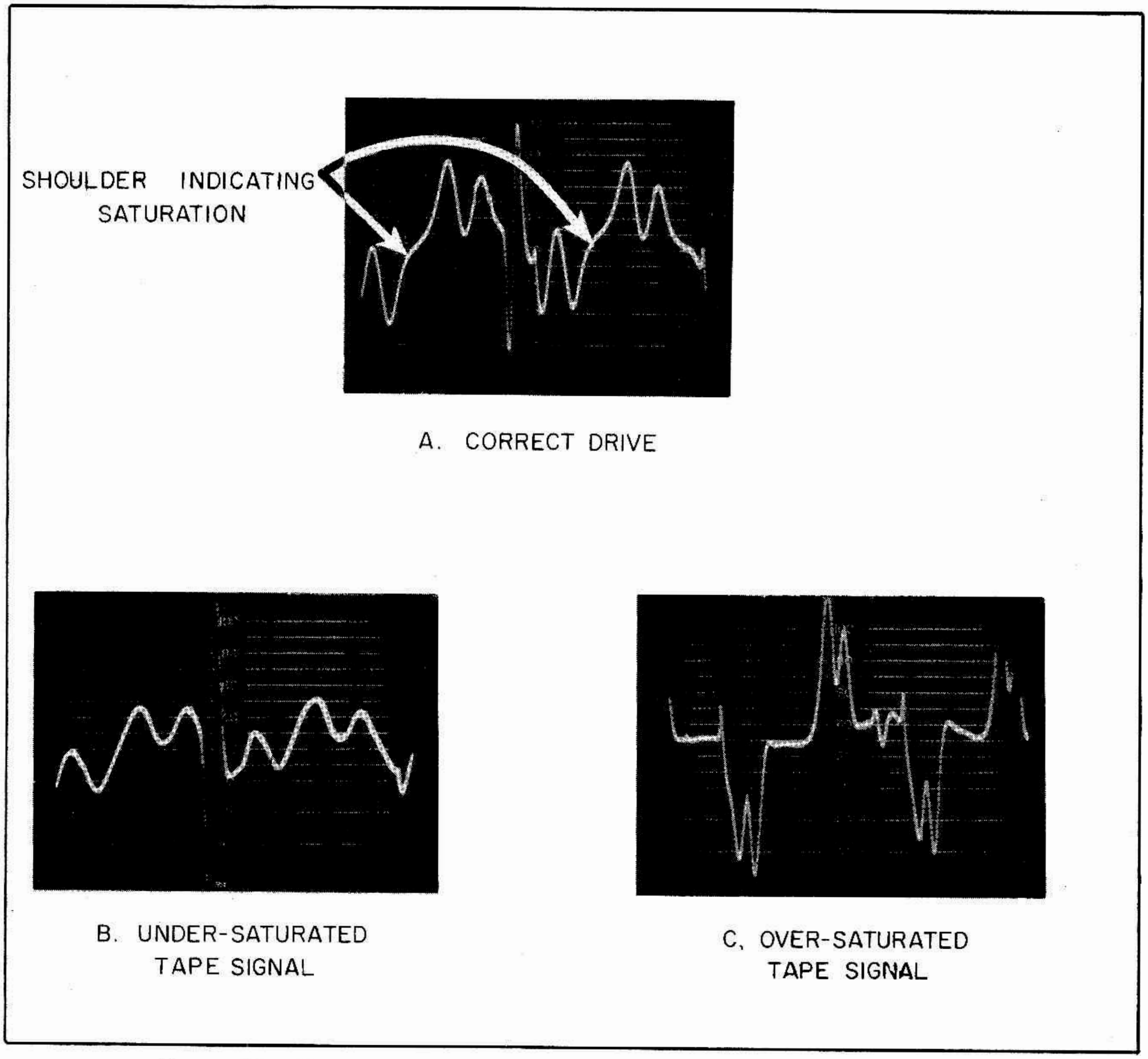
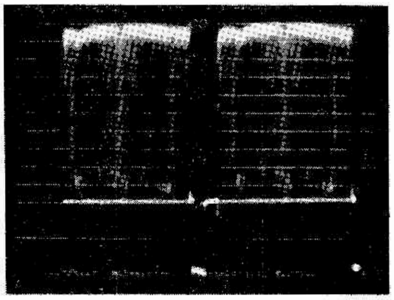
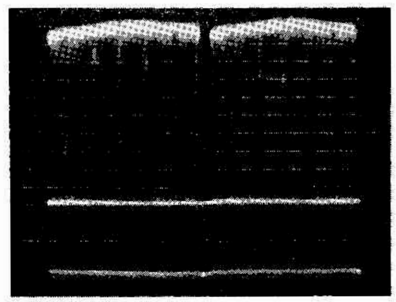


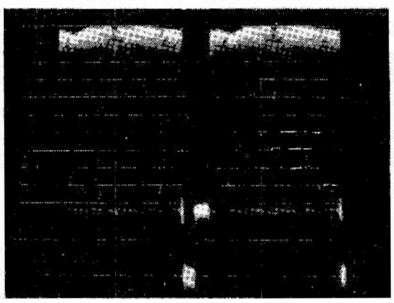
Figure 13—Simultaneous Control Track Playback (CT PB) Waveforms



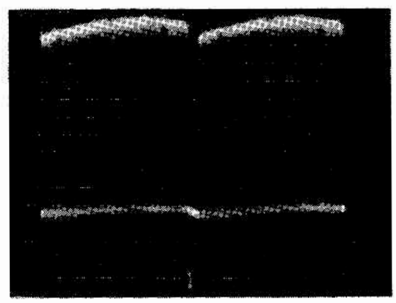
VID IN
(Horiz. Rate)



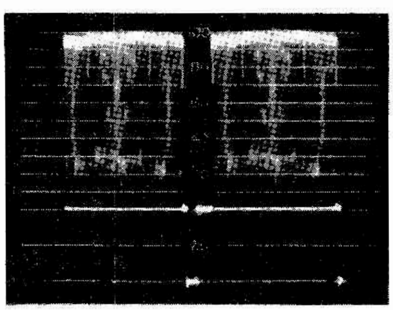
VID IN
(Vert. Rate)



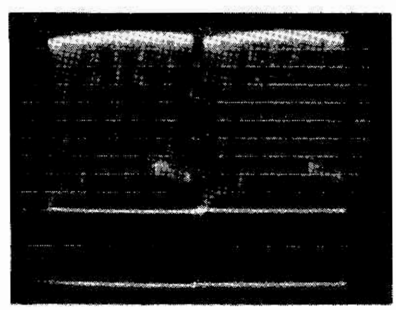
DEMOD OUT
(Horiz. Rate)



DEMOD OUT
(Vert. Rate)

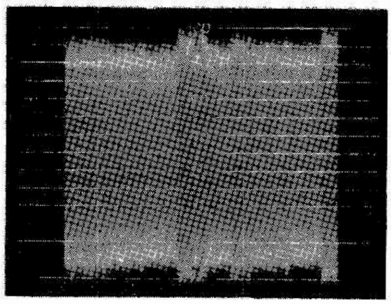


LINE OUT
(Horiz. Rate)

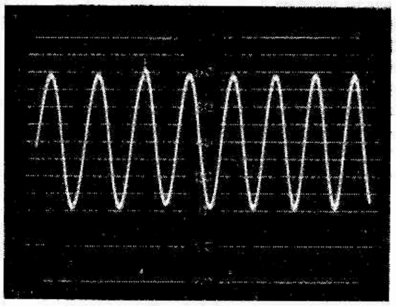


LINE OUT
(Vert. Rate)

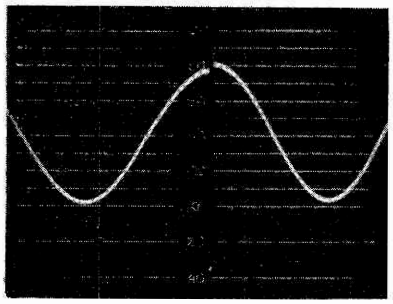
Figure 14—Waveforms on CRO Monitor Selected by Pushbuttons on CRO/Monitor Switcher



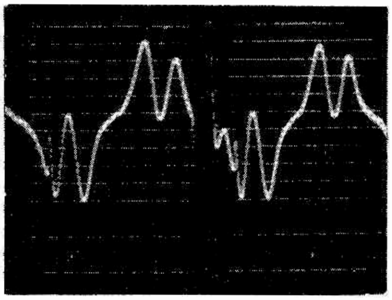
2 X 1 OUT
(240 Rate)



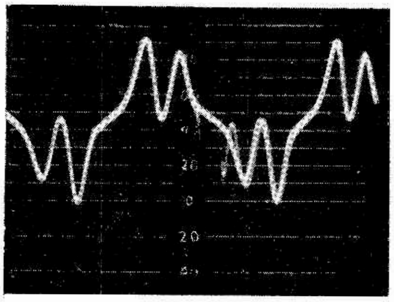
CT REC
(Vert. Rate)



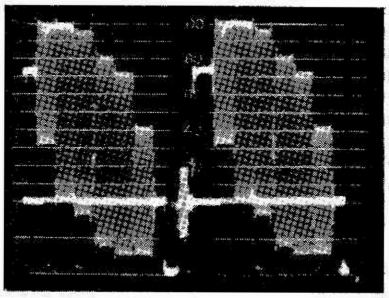
CT REC
(Expanded)



CT PB
(Playback)

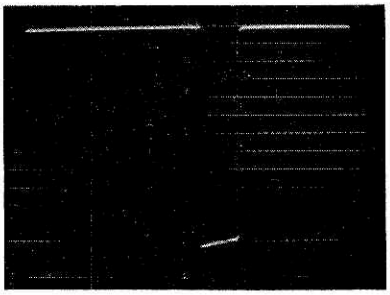


CT PB
(Simul. Playback-Record)

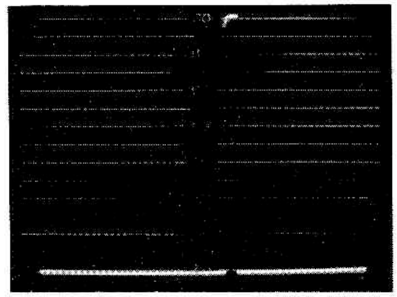


TEST VID

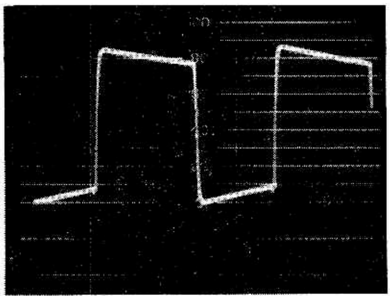
Figure 15—Waveforms on CRO Monitor (Continued)



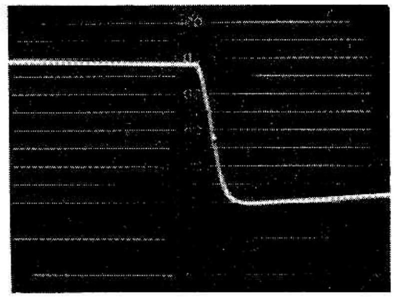
REF PULSE
(240 Expanded)



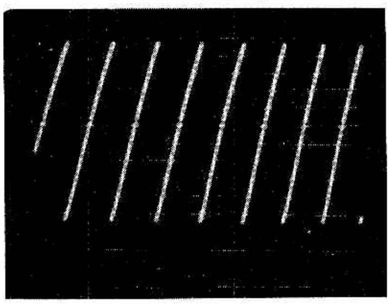
TW PULSE
(240 Expanded)



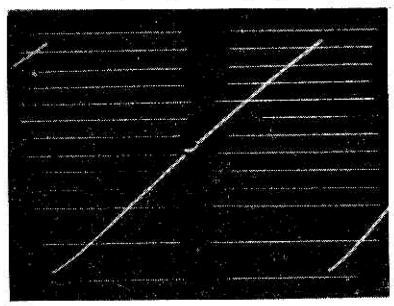
HW SERVO
(240 Rate)



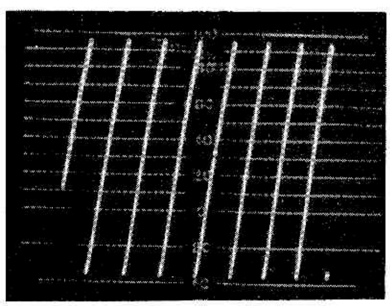
HW SERVO
(Expanded)



CAP SERVO
(Vert. Rate-Playback)



CAP SERVO
(Expanded-Record)



CAP SERVO
(Vert. Rate-Record)

Figure 16—Waveforms on CRO Monitor (Continued)

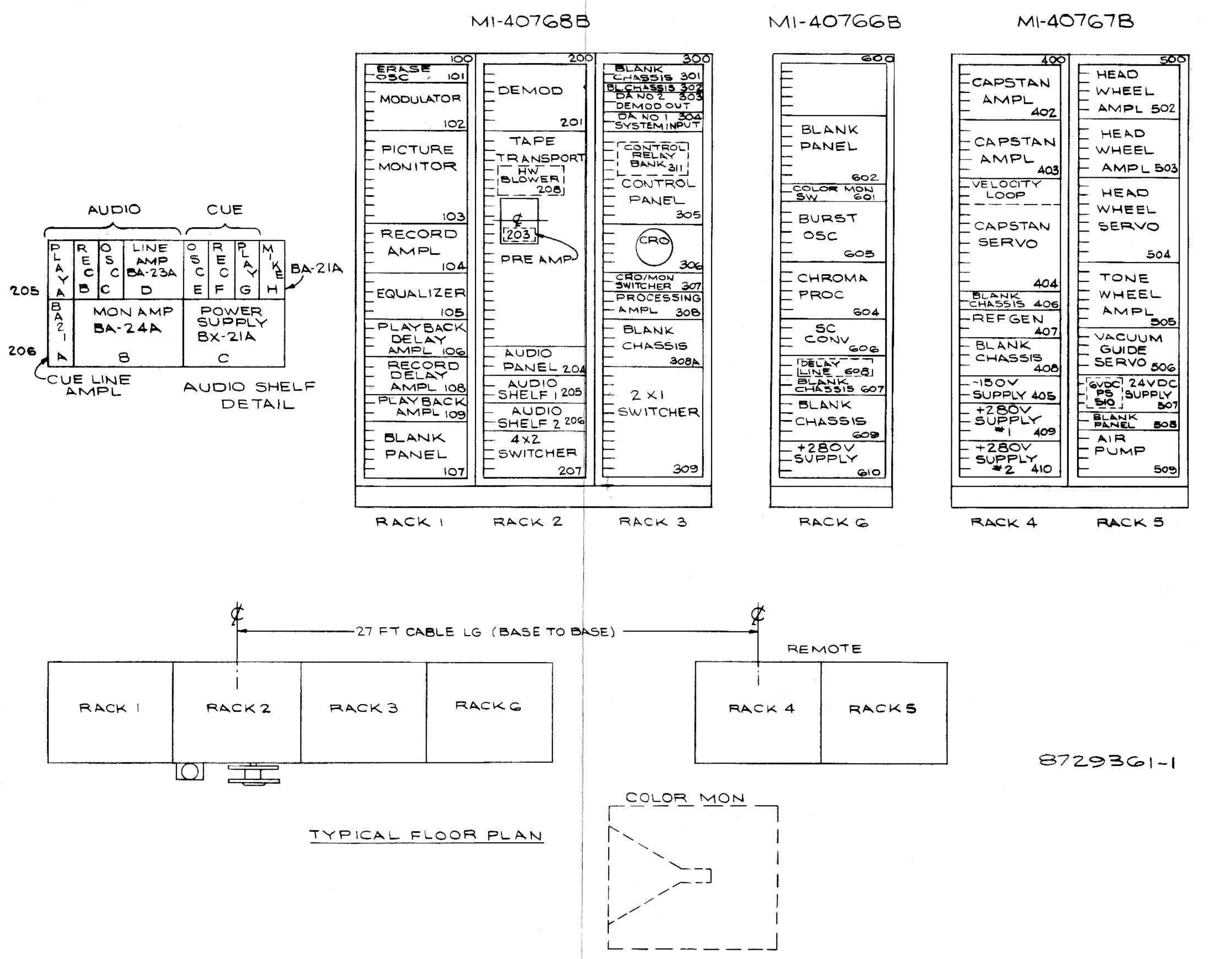


Figure 17—Rack Layout Diagram

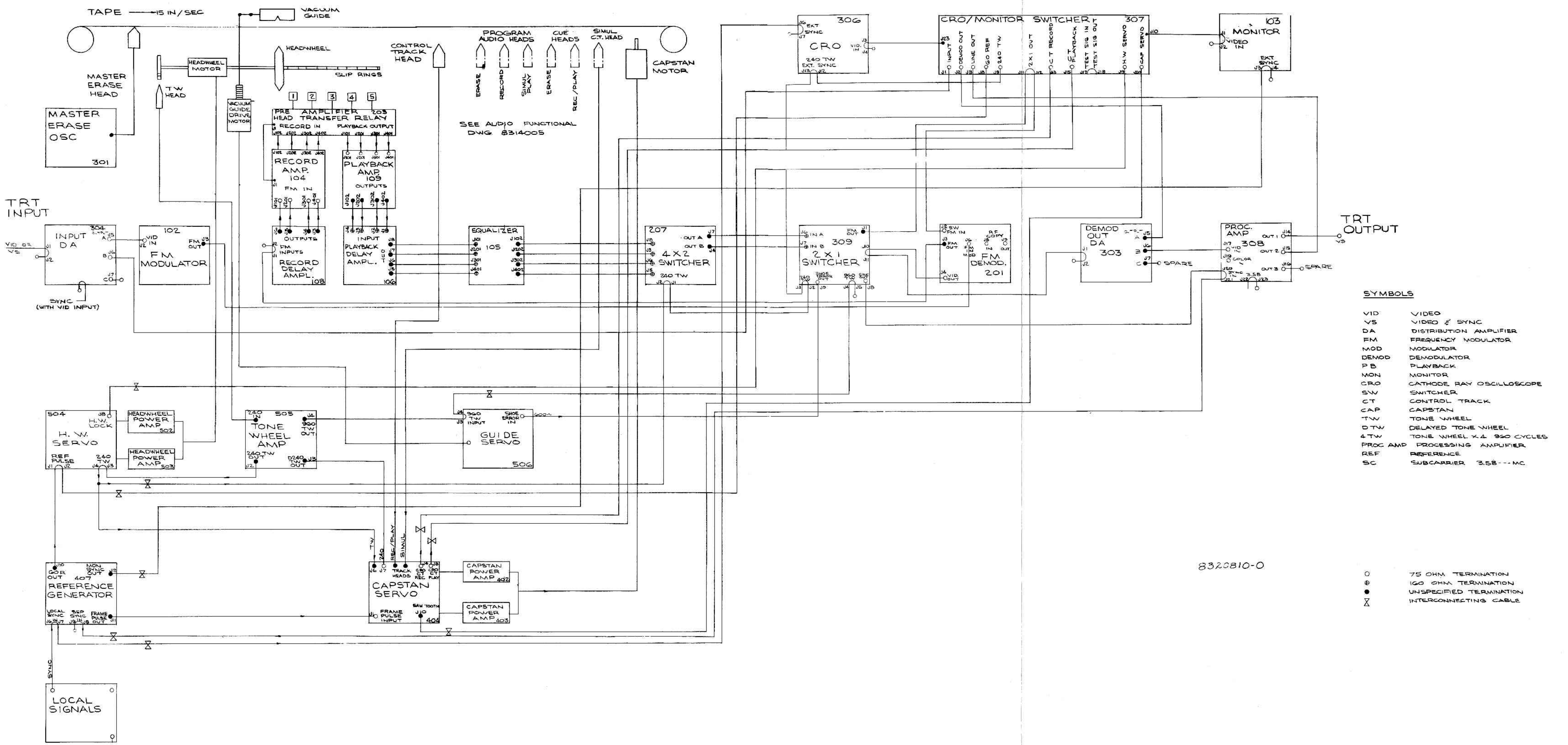


Figure 18—Video Functional Diagram, Monochrome

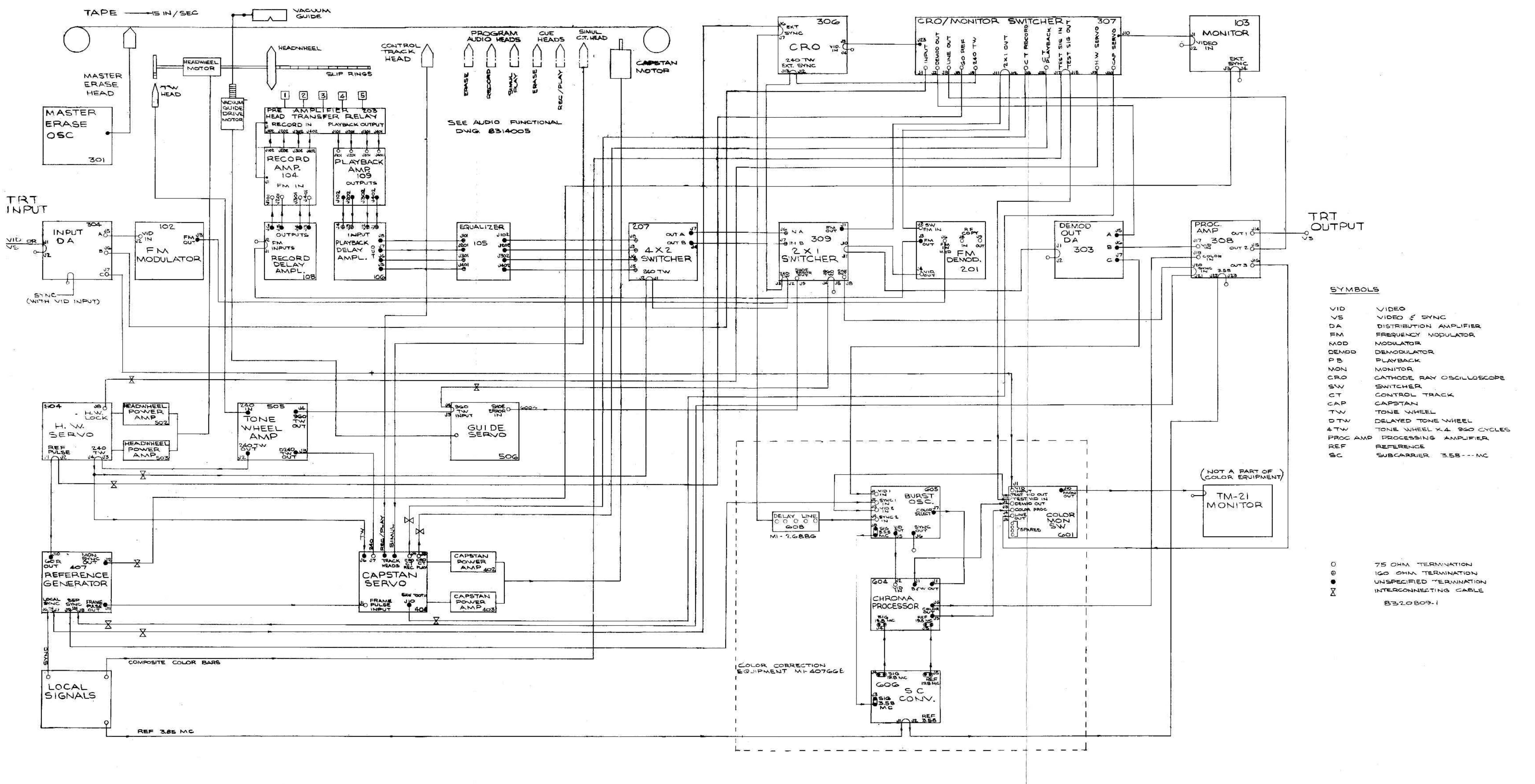


Figure 19—Video Functional Diagram, Color

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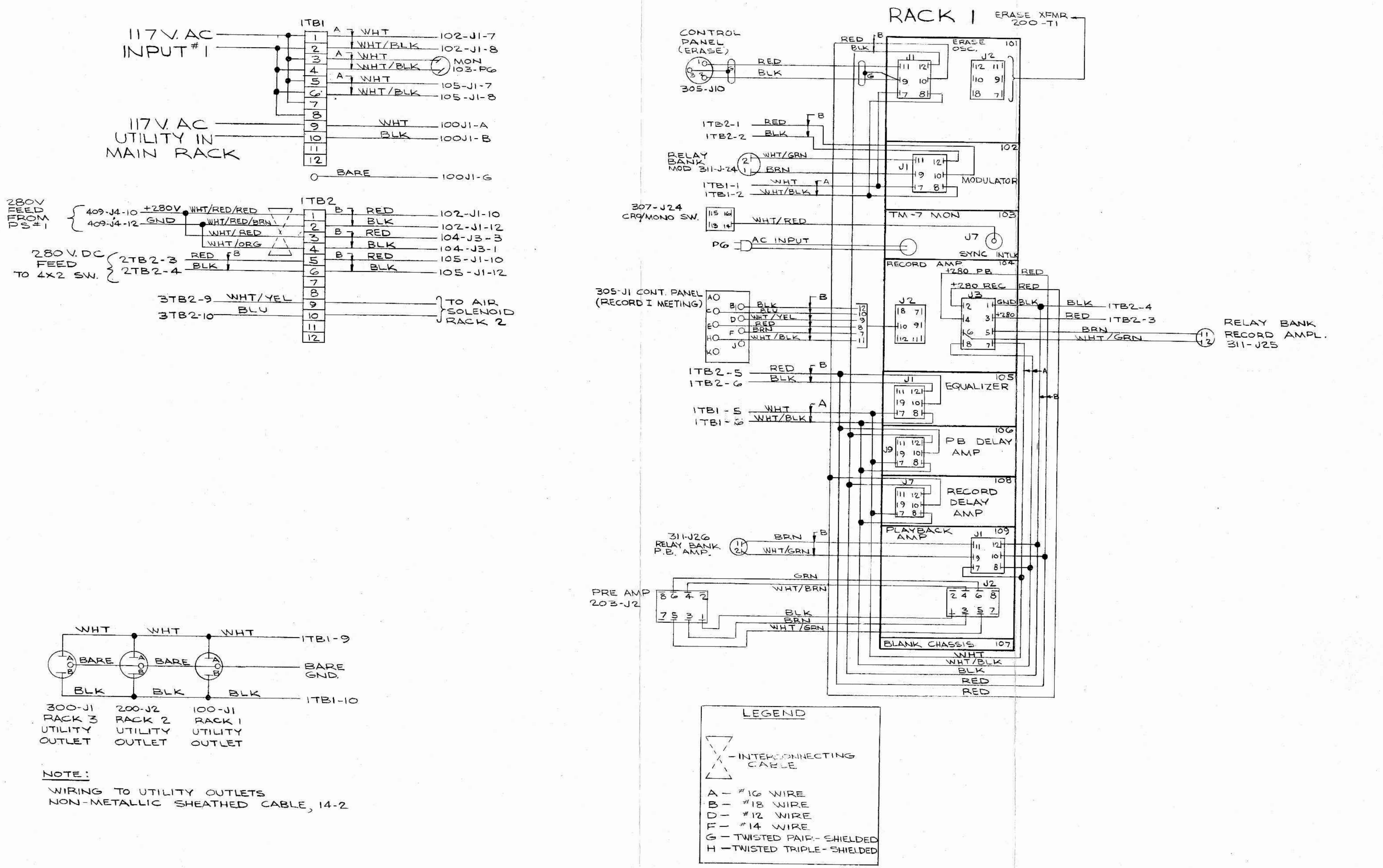
PARTS LIST

Symbol No.	Stock No.	Drawing No.	Description
			RACK #1 (8975561-503) 14
			Miscellaneous:
103-J6	4577	67089-3	Connector: male, 2 contact, cable mtg.
103-P1	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter - solder type
103-P2	210715	8909771-501	Connector: coax termination
103-P3	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter - solder type
103-P4	210715	8909771-501	Connector: coax termination
103-P6	4573	67089-4	Connector: female, 2 contact, cable mtg.
103-P7	31048	82373-4	Connector: male, 2 contact, cable mtg.
1TB1, 1TB2		449691-5	Board: terminal
	56070	448381-1	Relay: sync interlock (MI-26544)
103A1 thru 103A4	53906	255223-5	Connector: right angle adapter



Interconnection Diagram, Rack 1

Erase Oscillator

UNIT 101

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
DU 631

IB-31132

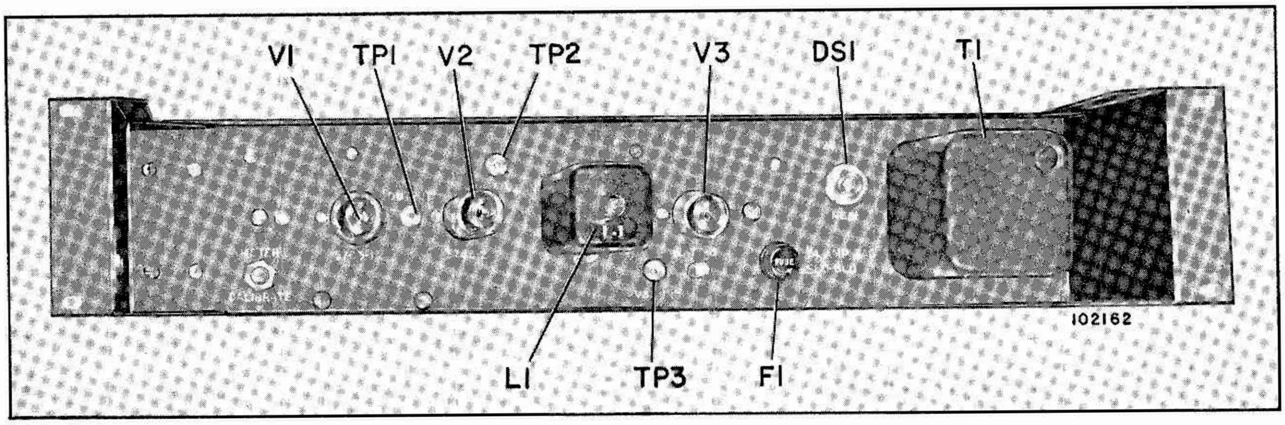


Figure VEO-1. Erase Oscillator

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles, 12 watts
DC: 280 volts, 85 ma. (From

Output Voltage

450 volts peak-to-peak (*Transformer T1 primary)
4.0 volts peak-to-peak (*Transformer T1 secondary)

Fuse

(1) 0.25 amp, type 3AG Slo-Blo

Tube and Diode Complement

(2) 5763	(2) 1N54A
(1) 12AT7	

* Transformer T1 located on Tape Transport Panel.

DESCRIPTION

The Erase Oscillator consists of a master oscillator, a cathode-follower buffer, and two parallel-connected power amplifiers. This circuit provides a 450 volt peak-to-peak, 100 kc sine wave signal to a step-down transformer (T1) on the tape transport panel; it is only available in the record mode of operation. The transformer output signal, which is a low-voltage, high-current signal suitable for erasing all recorded signals from the tape, is fed to the master erase head on the tape transport panel and is also returned to a rectifier circuit on the erase oscillator chassis. The rectifier output is applied to the control panel MASTER ERASE meter to permit monitoring of the erase current during record.

Circuit

The circuit of the erase oscillator is shown in the schematic diagram (Figure VEO-9). Oscillator stage V3A is a modified Colpitts oscillator operating at a frequency of about 100 kc, which can be adjusted slightly by tuning inductor L1. The oscillator output developed across the grid tank (L1, C2, and C3) is a sine wave with a peak-to-peak amplitude of 100 volts. This voltage is reduced to about 35 volts by a voltage divider (R2 and R3) and then applied to the cathode-follower buffer (V3B) which prevents variations in the power amplifiers from affecting the frequency stability of the oscillator. The buffer output, approximately 20 volts, is raised to 450 volts peak-to-peak by parallel-connected amplifiers V1 and V2, and then fed through pins 7 and 8 of connector J8 to transformer T1 on the tape transport panel. The output of transformer T1 is applied to the master erase head, and it is also returned through pins 11 and 12 of connector J8 to a rectifier circuit on the erase oscillator chassis consisting of crystal diodes CR1 and CR2. The rectifier output is fed through the METER CALIBRATE potentiometer R12 and pin 11 of jack J1 to the MASTER ERASE meter on the control panel.

ADJUSTMENTS

Master Oscillator Frequency

To adjust the master oscillator frequency proceed as follows:

1. Press the control panel SETUP button.
2. Adjust plug L1, on top of inductor shield, for maximum deflection on the control panel MASTER ERASE meter.
3. Check the voltage across the master erase head by connecting an a.c. voltmeter between terminals 5 and 6 of transformer T1 on the tape transport panel. The reading should be 4.0 volts peak-to-peak (minimum); see Figure VEO-2.

4. Adjust the METER CALIBRATE control on the erase oscillator for a reading on the MASTER ERASE meter corresponding to the voltage across the erase head.

NOTE: During operation, if the reading on the MASTER ERASE meter falls below 3.5 a signal level check should be made as outlined under MAINTENANCE.

MAINTENANCE

The erase oscillator requires no maintenance during normal operation with the exception of replacing defective tubes. If the proper indications cannot be obtained while adjusting the master oscillator, make the following signal level checks:

Power Amplifiers. Connect the oscilloscope to test point OUTPUT (TP1). The signal amplitude should be approximately 450 volts peak-to-peak (see Figure VEO-3). If this amplitude is not obtained replace tubes V1 and V2.

Buffer. Connect the oscilloscope to test point V1 and V2 INPUT (TP2). The signal amplitude should be approximately 20 volts peak-to-peak (see Figure VEO-4). If this amplitude is not obtained replace tube V3.

Oscillator. Connect the oscilloscope to test point V3B IN (TP3). The signal amplitude should be approximately 35 volts peak-to-peak (see Figure VEO-5). If this amplitude is not obtained replace tube V3.

TUBE VOLTAGE TABLE

Symbol	*Pin Number*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1	275	—	13.8	6.3 ac	0	160	13.8	7.3	—
V2	275	—	13.8	6.3 ac	0	160	13.8	7.3	—
V3	279	−3.5	+.22	0	0	279	0	7.3	6.3 ac

Voltage at jack J1 pin 11 is +0.03 volt.
Voltage at the junction of CR2, CR10, and R14 is +3.6 volts.

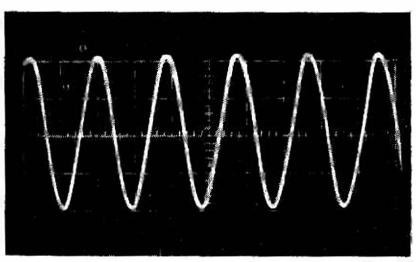


Figure VEO-2.
Erase Head Voltage
Amplitude: 1 volt/cm
Sweep Rate: 5 micro sec/cm

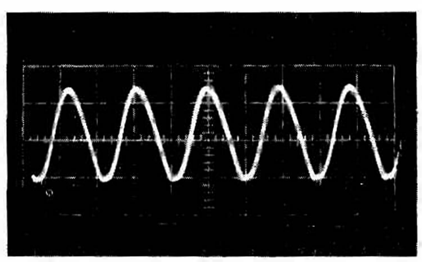


Figure VEO-3.
Test Point TP1
Amplitude: 200 volts/cm
Sweep Rate: 5 micro sec/cm

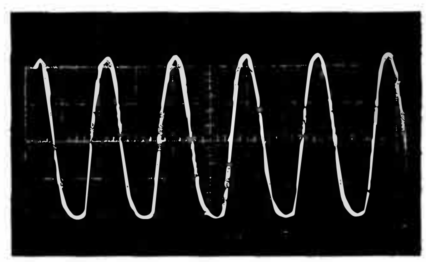


Figure VEO-4.
Test Point TP2
Amplitude: 5 volts/cm
Sweep Rate: 5 micro sec/cm

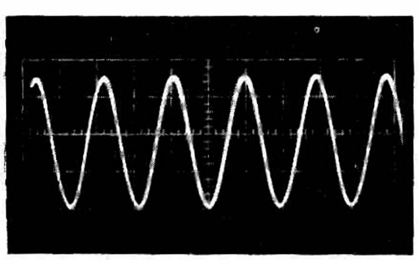


Figure VEO-5.
Test Point TP3
Amplitude: 10 volts/cm
Sweep Rate: 5 micro sec/cm

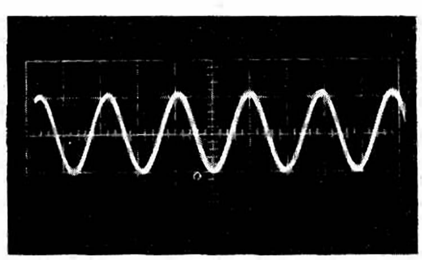


Figure VEO-6.
Tube V3 Grid (2)
Amplitude: 50 volts/cm
Sweep Rate: 5 micro sec/cm

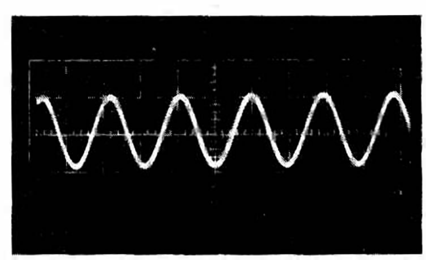


Figure VEO-7.
Tube V3 Cathode (3)
Amplitude: 10 volts/cm
Sweep Rate: 5 micro sec/cm

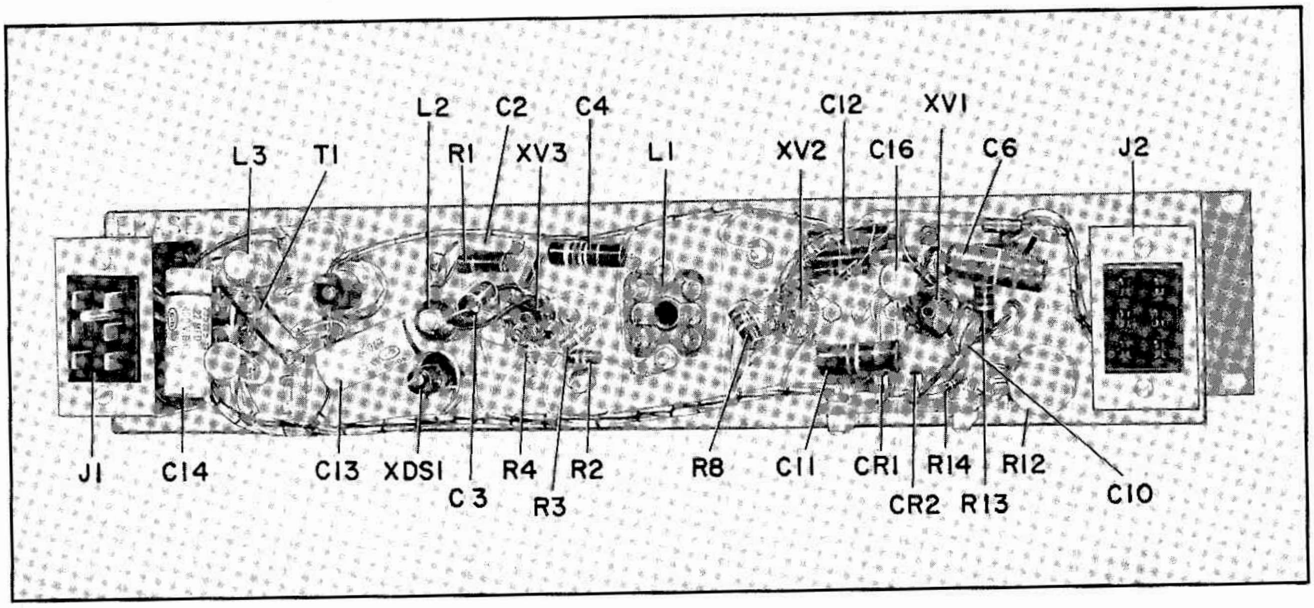
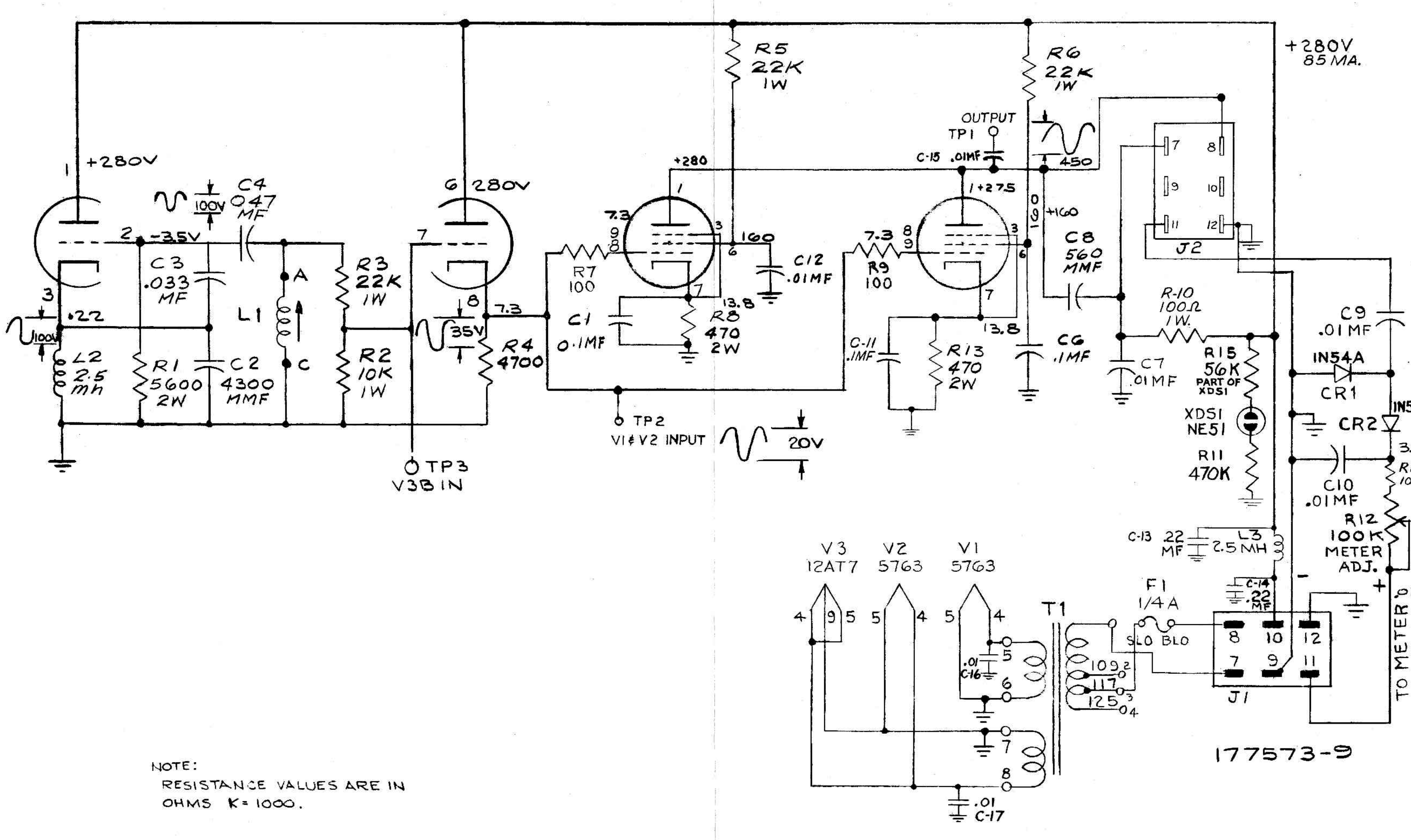


Figure VEO-8. Erase Oscillator, Rear View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			CAPACITORS:
C1		735715-75	Paper, 0.1 μf ±10%, 200 v
C2		727871-262	Mica, 4300 $\mu\mu$f ±5%, 500 v - char "B"
C3		735715-169	Paper, 0.033 μf ±10%, 400 v
C4		735715-71	Paper, 0.047 μf ±10%, 200 v
C5			Not Used
C6		735715-175	Paper, 0.1 μf ±10%, 400 v
C7		735715-163	Paper, 0.01 μf ±10%, 400 v
C8		727856-141	Mica, 560 $\mu\mu$f ±10%, 300 v - char "B"
C9, C10		8811182-5	Ceramic, 10,000 $\mu\mu$f -20 +100%, 450 v
C11		735715-75	Paper, 0.1 μf ±10%, 200 v
C12		735715-163	Paper, 0.01 μf ±10%, 400 v
C13, C14		735715-179	Paper, 0.22 μf ±10%, 400 v
C15 to C17		8811182-5	Ceramic, 10,000 $\mu\mu$f -20 +100%, 450 v
CR1, CR2	99483	8981515-3	Diode: Type 1N54A
DS1	101857	872291-9	Lamp: indicator NE51
F1	218140	8858508-22	Fuse: 1/4 amp, 250 v
J1	51604	727969-3	Connector: male, 6 contact
J2	51594	727969-1	Connector: female, 6 contact
L1	218139	728446-19	Coil: variable
L2	218776	8835360-3	Reactor: choke, 2.5 mh, 300 ma
L3	218776	8835360-3	Reactor: R.F. choke, 2.5 mh, 300 MA
P1	51607	727969-4	Connector: female, 6 contact
P2	51595	727969-2	Connector: male, 6 contact
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		99126-71	5600 ohm ±10%, 2 w
R2		90496-74	10,000 ohm ±10%, 1 w
R3		90496-78	22,000 ohm ±10%, 1 w
R4		82283-70	4700 ohm ±10%, ½ w
R5, R6		90496-78	22,000 ohm ±10%, 1 w
R7		82283-50	100 ohm ±10%, ½ w
R8		99126-58	470 ohm ±10%, 2 w
R9		82283-50	100 ohm ±10%, ½ w
R10		90496-50	100 ohm ±10%, 1 w
R11		82283-94	470,000 ohm ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R12	205044	8971860-114	Variable, 100,000 ohm ±10%, 2 w
R13		99126-58	470 ohm ±10%, 2 w
R14		82283-86	100,000 ohm ±10%, ½ w
R15			Part of XDS1
R16			Not Used
R17			Not Used
T1	57021	949069-1	Transformer: filament
TP1 to TP3	208983	8825493-7	Jack: tip, yellow
XADS1	208080	990788-507	Lens: indicator lamp
XDS1	208458	990789-5	Holder: lamp
XF1	48894	99088-2	Holder: fuse
XV1 to XV3	94926	737870-14	Socket: tube



NOTE:
RESISTANCE VALUES ARE IN
OHMS K = 1000.

Figure VEO-9. Erase Oscillator Schematic Diagram

Modulator

UNIT 102

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
GO 641

IB-31133

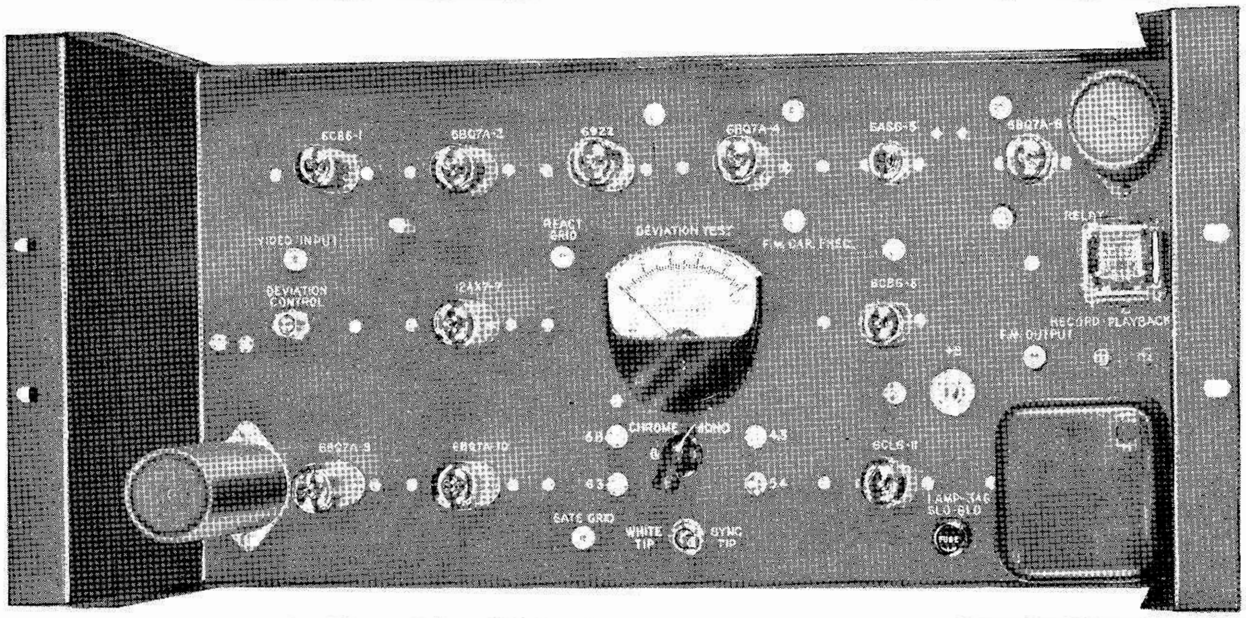


Figure MOD-1. Modulator

TECHNICAL DATA

Power Requirements

AC: 117 volts, 50/60 cycles, .32 amps, 37 watts (from circuit breaker No. 1)

DC: 280 volts, 170 ma, 48 watts (from power supply No. 1, unit 409)

Video Input Signal Level

1.0 volt peak-to-peak (composite video signal)

Input Impedance

75 ohms

Video Pre-emphasis at 4 mc

Mono: 4.0 db
Color: 9.54 db

Carrier Frequency Limits

	*Sync Tip**	*White Tip*
*Mono***	4.3 mc	6.8 mc
Color	5.4 mc	6.3 mc

FM Output Signal Level

1.0 volt peak-to-peak

Output Impedance

75 ohms

Tube and Diode Complement

1	6AS6	1	12AX7
5	6BQ7A	1	6CL6
2	6BC6	1	6922
1	1N54A		

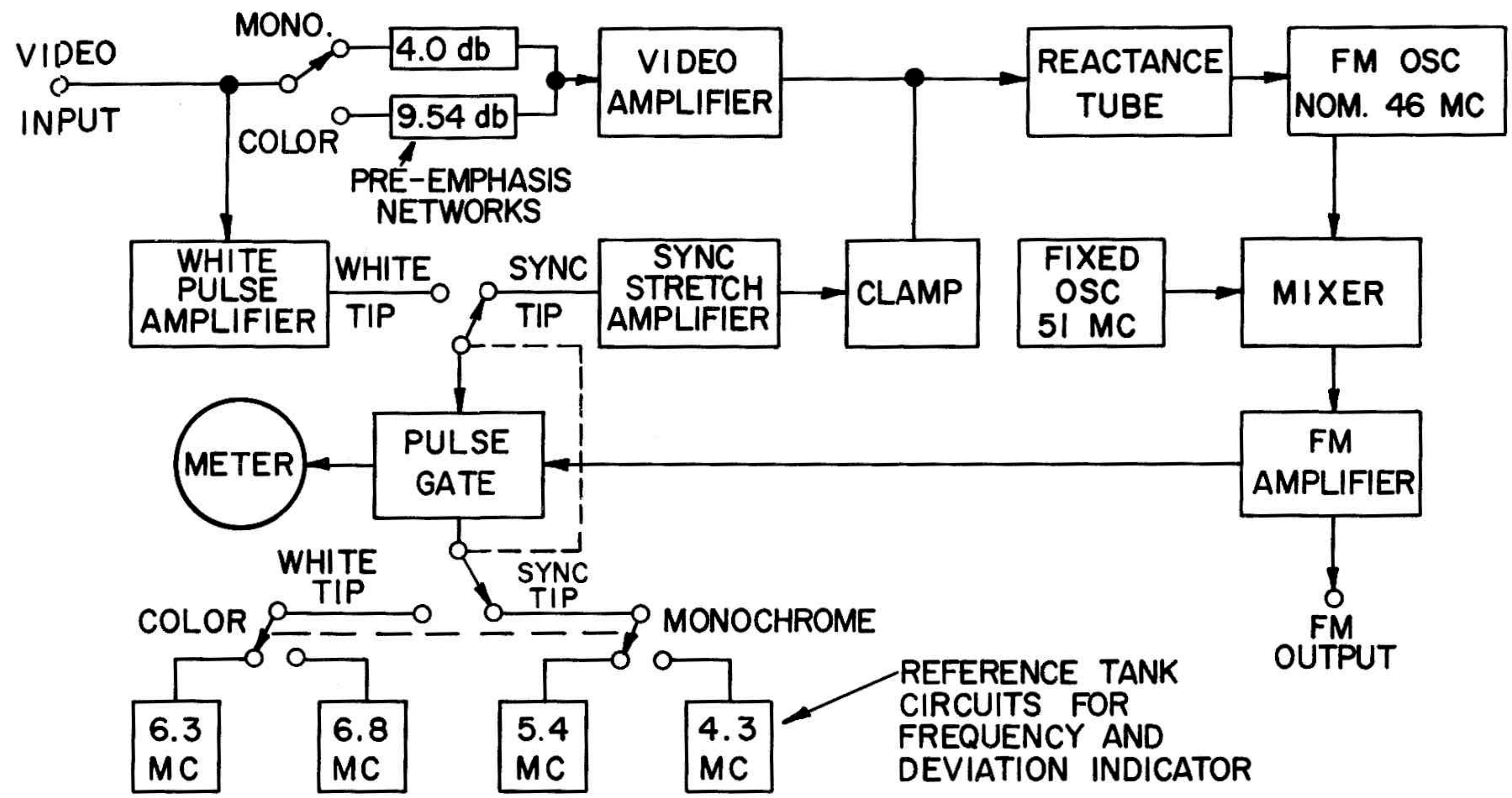
* The output frequency at tip of sync is clamped to this value to preserve the dc component.

** SMPTE recommended practice RP6 — see SMPTE Journal — December, 1960.

DESCRIPTION

The modulator (unit 102) located at the top of Rack 1, converts the incoming video information from the input distribution amplifier (unit 304) to a frequency modulated signal. For normal operation in the record and setup modes, the fm output signal of the modulator is looped through the demodulator to permit monitoring of the processed video information on the CRO waveform monitor or picture monitor, and is applied to the record delay amplifier (unit 108). From the record delay amplifier it passes through the record amplifier (unit 104) and is applied to the four video heads of the headwheel. In the playback mode the modulator is disabled, producing no output.

For rf copy two tape machines are required, one for sending and one for receiving the rf information. When recording a tape by rf copy, the modulator of each tape recorder is disabled. However, to set up the tape recorders prior to making rf copy, the modulator of the sending recorder is turned on and the modulator of the receiving recorder is turned off. The fm signal generated by the sending recorder is transmitted from its rf copy output to the rf copy input of the receiving recorder. In the receiving recorder, the fm signal is processed to provide a video output for monitoring at the CRO waveform monitor or picture monitor. For any mode of rf copy operation, video output signals are available simultaneously from both recorders.



SIMPLIFIED BLOCK DIAGRAM OF TRT-1A MODULATOR

Figure MOD-2. Modulator Block Diagram

Circuit

Modulator. During the following discussion of the modulator refer to the block diagram (Figure MOD-2) and the schematic diagram (Figure MOD-7). The incoming video signal (monochrome or chrome) from the distribution amplifier is applied to a potentiometer (R2) labeled DEVIATION CONTROL. From the center arm of the potentiometer the video signal is fed to one of two pre-emphasis networks depending on the position of the CHROME-MONO switch. By the use of pre-emphasis at the high video frequencies and a corresponding de-emphasis after demodulation, the overall signal-to-noise ratio is increased. The amount of pre-emphasis used is that recommended by the SMPTE: 4.0 db at 4 mc for monochrome, and 9.54 db at 4 mc for color. In monochrome operation, the increase in signal-to-noise ratio over that obtained without pre-emphasis is approximately 3 db. In color operation the signal to noise ratio is initially lower because of the compressed deviation range (5.4 to 6.3 mc). Therefore, a greater pre-emphasis is used providing an increase in signal to noise ratio of approximately 5 db over that obtained without pre-emphasis.

The pre-emphasis network output is applied to a video amplifier consisting of stages V1 and V2. Stage V1 is a conventional video amplifier except that no bypass capacitor is connected across the split cathode resistors R8 and R9. The degeneration thus obtained reduces the stage gain but stabilizes the performance. The output of video amplifier stage V1 is applied to the grid circuit of video amplifier V2A, which operates in a manner identical to that of amplifier V1. The video output signal of stage V2A is fed to a cathode-follower driver stage, V2B, which is capacitively coupled to the control grid of a reactance tube, V3A, and also to a sync stretch amplifier, V10B.

The reactance tube frequency modulates the oscillator stage V4 by effectively changing the amplitude variations of the input signal into a varying reactance which is connected across the fm oscillator tuned circuit. A voltage regulator stage, V3B, keeps the plate voltage of the reactance tube constant to insure that the clamp bias voltage applied to it holds the carrier frequency limit constant for tip of sync. Inductor L3 in the grid circuit of the reactance tube, in conjunction with the plate-to-grid capacitance of the tube, produces a ninety degree phase difference between the fm carrier voltages appearing at the plate and the grid. This phase difference is essential for proper operation of the reactance tube. Damping resistor R86 connected across inductor L3 broadens its response. Adjustment of L3 affects both the deviation sensitivity and the amount of amplitude modulation present in the fm signal. Ideally, when L3 is properly adjusted, the amount of amplitude modulation is minimum and the deviation sensitivity is such that there is proper tracking of the sync tip frequency when switching between chrome and monochrome operation. In practice, however, since tracking also depends on the clamp voltage applied to the grid of the reactance tube from pins 1 and 8 of stage V7, normal resistor tolerances cause these two conditions to occur at slightly different places. Therefore, factory adjustment of L3 is made for proper tracking of sync tip frequency. The amount of amplitude modulation, while not at a minimum, is within the tolerance assigned to it.

A clamp stage, V7, in conjunction with a non-linear sync stretch amplifier, V10B, is used to clamp the grid of the reactance tube to the desired voltage at the tip of sync. The clamp stage consists of the shunt connected back-to-back triodes with the junction of one plate and cathode (pin 3 of 6) connected to the floating grid of the reactance tube V3, and the junction of the other plate and cathode (pins 1 and 8) returned either to ground (switch S2 in MONO position) or to a point on a voltage divider slightly above ground (switch S2 in CHROME position). Because of the back-to-back connection current can flow in either direction, and the tube acts as a switch connecting the junction at pins 1 and 8, through resistor R51, to the clamp capacitor C7 in the grid circuit of V3.

When the signal is at tip of sync the non-linear sync stretch amplifier (V10B) produces a pulse which drives both grids of V7 positive and effectively closes the switch. The clamp capacitor (C7) then charges or discharges to the potential at pins 1 and 8 of V7 (0 volts for MONO; +0.73 volts for CHROME). During any part of the signal, except tip of sync, the sync stretch amplifier (V10B) produces insufficient output to keep the clamp tube conducting, and since the charge path of capacitor C7 is effectively open, the charge remains constant; however, signal variations are instantaneously passed through C7.

The fm oscillator V4 consists of a dual triode with feedback provided by a common cathode inductor, L6, and a capacitor, C13, from the plate of the first section to the control grid of the second. The oscillator frequency is determined by inductor L5 (F.M. CAR. FREQ.) in the plate circuit of the first section and the variable reactance connect across it. The fm output signal of variable frequency oscillator V4, with a center frequency of approximately 45 mc., is coupled to the control grid of the mixer stage V5 through

capacitor C29. It is heterodyned with the output signal of the master oscillator V6, which is injected into the suppressor grid circuit. The frequency of the master oscillator is about 51 megacycles and is not critical. The operation of the master oscillator V5 is the same as the fm oscillator V4; the coupling between stages is through the common cathode impedance L8 and coupling capacitor C17. The mixer output signal is applied to two fm amplifier stages, V8 and V11. Inductors L12 and L14, in the control grid circuits of V8 and V11, provide high frequency peaking to keep the response flat to 10 mc. These coils also prevent unwanted signals at the oscillator frequencies and their sum from getting into the fm output. The resulting output of amplifier V11 is a frequency modulated signal equal to the difference between the two oscillator frequencies. The instantaneous frequency of the output will vary from 4.3 mc during sync tip to 6.8 during white tip for monochrome operation and from 5.4 to 6.3 mc for chrome operation.

Deviation Test Meter. The meter labeled DEVIATION TEST is used when adjusting the frequency of the fm oscillator V4. A portion of the fm output voltage of amplifier V11 is coupled to the cathode circuit of the gate tube V10A through capacitor C26. The gate tube is in a non-conducting state, and will not conduct unless a positive going voltage pulse is applied to its grid.

When switch S1 is in the SYNC TIP position, positive going sync pulses from the sync stretcher (V10B) are applied to the control grid of the gate tube (V10A) forcing it to conduct during the sync period. When V10A conducts, it passes the rf signal appearing at its cathode to one of the tuned reference circuits in the plate (L10-C24 or L17-C43) depending on the position of the CHROME-MONO switch (S2). The voltage developed across the tuned circuit is rectified by germanium diode CR1 and its average value is indicated on the meter labeled DEVIATION TEST. Maximum deflection of the meter will be obtained when the frequency to which the rf carrier is clamped during sync tip equals that of the reference circuit selected.

When switch S1 is in the WHITE TIP position, the white information of the incoming video signal is used to trigger the gate tube V10A. The incoming video signal has positive signal polarity; that is, the white information is the most positive part of the signal. Incoming video information is applied to the white pulse amplifier V9. Stage V9A (pins 1, 2, and 3) has a high positive bias voltage on the cathode and a low value of plate voltage; therefore, the tube will conduct only on the most positive part of the input signal (white information). The signal at the plate of V9A has negative picture polarity due to the phase reversal of the tube. Stage V9A output is coupled to V9B where it is amplified and inverted to the original polarity. The output of V9B is used to trigger the gate tube V10A forcing it to conduct for the duration of the white signal. When V10A conducts, an rf voltage is developed across the plate tuned circuit (L9-C23 or L16-C42) depending on the position of the CHROME-MONO switch. (Maximum deflection of the DEVIATION TEST meter will be obtained when the frequency of the rf carrier during white tip is equal to that of the reference circuit selected.)

Record-Playback Relay

The record-playback relay, K1, when de-energized disables the modulator by removing the plate voltage from the mixer stage (V5) and the two fm amplifiers (V8 and V11). Relay K1 is energized by certain combinations of the pushbuttons on the control panel as outlined in the following table.

RECORD-PLAYBACK RELAY OPERATION

Mode of Operation	*Pushbutton Pressed*	*Condition of K1*
Normal { Record or Setup	RECORD or SET UP	Energized
Normal { Play or Stop	PLAY or STOP	De-energized
RF Play (Send)	RF COPY and PLAY	De-energized
RF Record (Receive)	RF COPY and RECORD	De-energized
RF Setup (Send) (Between 2 Recorders)	RF COPY and SETUP	Energized
RF only (Between 2 Recorders)	RF COPY	De-energized

ADJUSTMENTS

The following adjustments should be made before starting operation, or at least once a day if the tape recorder is to be in continuous operation.

1. Press the control panel SETUP button.

2. Press the oscilloscope VID IN button on the CRO/Mon Switcher.

3. Adjust the VIDEO GAIN control on the input distribution amplifier to obtain a reading of 1 volt peak-to-peak (140 IRE units) on the CRO (Figure MOD-3).

NOTE: The input video signal may be a monoscope pattern, color bar pattern, or any other form of stationary signal provided there is an appreciable WHITE area (at least five microseconds wide).

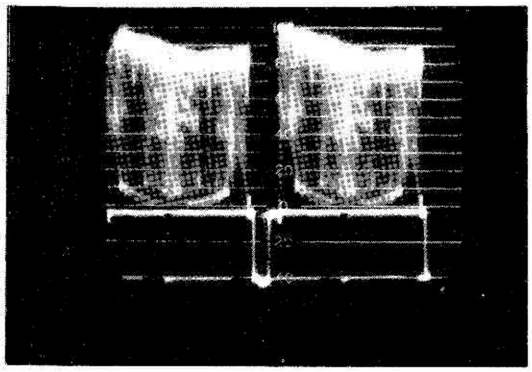


Figure MOD-3. Video Input Signal, 1.0 Volt P/P (140 IRE Units)

4. Place the modulator CHROME-MONO switch in the position corresponding to the deviation limits to be recorded.

5. Place the WHITE TIP-SYNC TIP switch in the SYNC TIP position.

6. Adjust the F.M. CAR. FREQ. control for maximum deflection on the DEVIATION TEST meter.

7. Place the WHITE TIP-SYNC TIP switch in the WHITE TIP position.

8. Adjust the DEVIATION CONTROL for maximum deflection on the DEVIATION TEST meter.

9. Place the WHITE TIP-SYNC TIP switch in the SYNC TIP position and leave it there during operation.

MAINTENANCE

After the modulator has been properly adjusted, little maintenance is needed except for the replacement of defective tubes.

Reference Circuit Check

If it becomes necessary to check or change the frequency of any of the deviation reference circuits, either a direct method or a more convenient but less direct method may be used. Either method requires use of an unmodulated rf signal generator with a frequency adjustable between 4.3 and 6.8 megacycles at an accuracy of ±50 kc, and an output voltage adjustable from 0.05 to 1.0 volt.

Direct Method. To check the frequencies of the reference circuits directly, proceed as follows:

1. Remove the oscillator tubes V4 and V6. Mark the tubes in some manner so that they will be returned to their proper sockets.

2. Press the control panel SETUP button.

3. Connect an rf signal across capacitor C14, and set the generator output level to 1.0 volt peak-to-peak.

4. Vary the frequency of the signal generator between 4.3 and 6.8 megacycles, and note the frequencies that give maximum deflection on the DEVIATION TEST meter for both positions of the WHITE TIP-SYNC TIP switch; first with the CHROME-MONO switch in the CHROME position and then in the MONO position.

NOTE: If the reference circuit coils must be adjusted, they should be checked again after the locking nut is tightened firmly, but not tight enough to damage the internal friction spring.

5. Disconnect the signal generator, and return the oscillator tubes V4 and V6 to their proper sockets.

Indirect Method. The indirect method checks the actual deviation limits of the fm carrier after these limits have been set using the reference circuits. For video modulation, use a signal having a white area at least five microseconds wide, and proceed as follows:

1. Press the control panel SETUP button.

2. Place the modulator CHROME-MONO switch in the position corresponding to the deviation limits to be measured.

3. Place the WHITE TIP-SYNC TIP switch in the SYNC TIP position.

4. Adjust the FM CAR. FREQ. control for maximum on the DEVIATION TEST meter.

5. Place the WHITE TIP-SYNC TIP switch in the WHITE TIP position.

6. Adjust the DEVIATION CONTROL for maximum deflection on the DEVIATION TEST meter.

7. Place the WHITE TIP-SYNC TIP switch in the SYNC TIP position.

8. Connect the oscilloscope probe to the demodulator test point VIDEO OUTPUT (TP2).

9. Connect the rf signal generator to the demodulator test point FM INPUT (TP1).

10. Vary the rf signal generator frequency to obtain zero beats at both the sync tip and white tip frequencies as observed on the oscilloscope. Record the signal generator frequencies for these deviation limits.

NOTE: This deviation check method can also be used in the PLAY mode of operation to check the actual frequency limits on a tape of questionable quality or of unknown origin.

Amplitude Modulation Adjustment

To keep amplitude modulation to a minimum adjust inductor L3 as follows:

1. Feed a composite video signal to the input of the modulator.

2. Connect an oscilloscope, (Tektronix type 535 or equivalent) through a low capacity probe, to test point FM OUTPUT (TP3).

3. Place the CHROME-MONO switch in the CHROME position.

4. Adjust trimmer capacitor C14, on rear of chassis, for a signal amplitude of 1.0 volt peak-to-peak.

5. Adjust the A.M. ADJUSTMENT control for minimum amplitude modulation, as indicated on the oscilloscope. This adjustment changes the deviation sensitivity and therefore should not be made without also checking the tracking of the sync tip frequency when shifting from CHROME to MONOCHROME operation. Tracking may be checked by observing if the DEVIATION TEST meter is peaked on both MONO and CHROME without changing the setting of the FM CAR. FREQ. control. If the tracking is normal for sync tip, it is probable that inductor L3 is reasonably close to the correct setting.

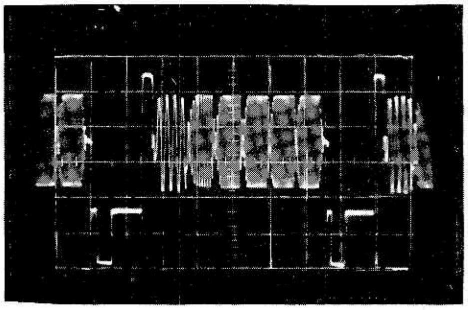
6. Place the CHROME-MONO switch in the desired position, and disconnect the oscilloscope.

General Trouble Shooting

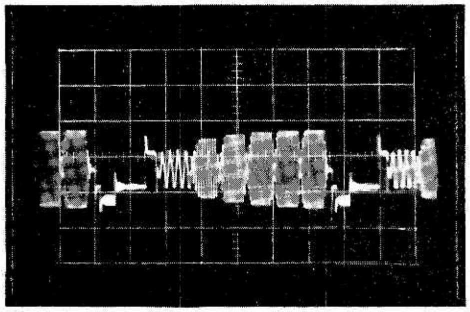
When trouble develops, the waveforms (Figures MOD-4 and MOD-5) will be an aid in signal tracing the modulator to determine the malfunction. The waveforms were taken with the tape recorder in the setup mode of operation, and a composite video input signal with an amplitude of 1.0 volt peak-to-peak from a multiburst generator (Telechrome 1003C). A Tektronix type 535 oscilloscope with a high gain preamplifier (type 53/54c) and a 10:1 attenuator probe was used. The oscilloscope horizontal timing (sweep) was set to 10 microseconds per division, and locked to horizontal drive.

TROUBLE SHOOTING CHART

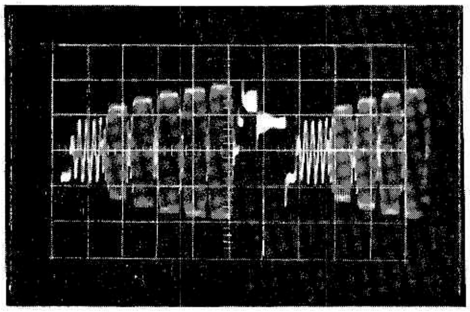
Trouble	*Probable Cause*	*Remedy*
Tube filaments not lit.	Fuse F1 defective.	Replace fuse F1.
No B+ voltage to tubes V5, V8, and V11 in the RECORD mode of operation.	Defective relay K1. Either solenoid winding open, or contacts dirty.	If the solenoid winding is open, replace relay. If relay contacts are dirty, clean with a fine burnishing tool.
Low or no fm output signal (as measured at TP3).	Weak tube or tubes.	Check tubes V5, V8, V11, V6, and V4 in that order. Replace defective tube or tubes.
Low deviation sensitivity and nonlinear modulation.	Weak reactance tube V3.	Replace V3. Readjust L5 (CAR. FREQ. CONTROL) and L3 (A.M. ADJUSTMENT) if necessary.
Hum modulation on fm carrier.	Low resistance from heater to cathode in V3 or V7.	Replace defective tube.
Low or high reading on DEVIATION TEST meter.	Abnormally low or high mutual conductance in tubes V9 or V10.	Replace with normal tubes.



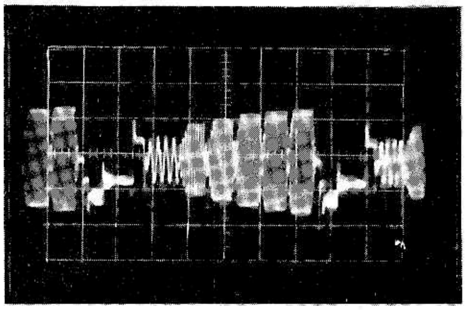
A. Deviation Control (TP1)
Amplitude: .1 volt/cm
Switch S1: Sync Tip
Switch S2: Chrome



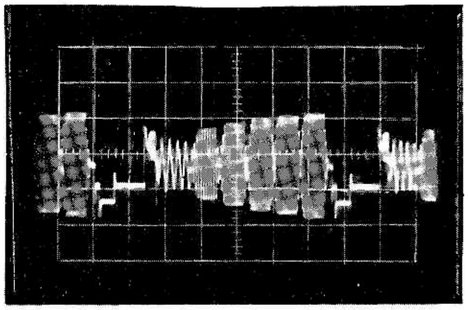
B. V1 Cathode (pin 2)
Amplitude: .05 volt/cm
Switch S1: Sync Tip
Switch S2: Chrome



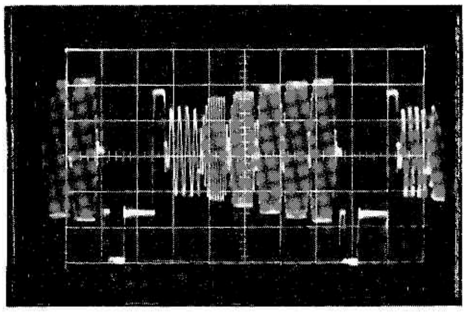
C. V2 Cathode (pin 3)
Amplitude: .05 volt/cm
Switch S1: Sync Tip
Switch S2: Chrome



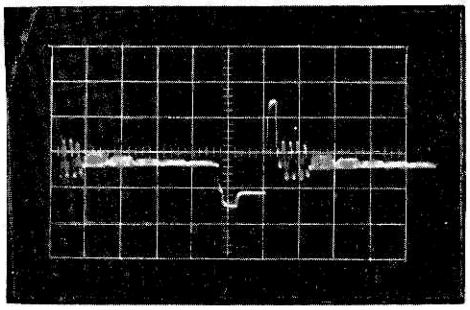
D. Reactance Tube Grid (TP2)
Amplitude: .5 volt/cm
Switch S1: Sync Tip
Switch S2: Chrome



E. Reactance Tube Grid (TP2)
Amplitude: .5 volt/cm
Switch S1: White Tip
Switch S2: Chrome

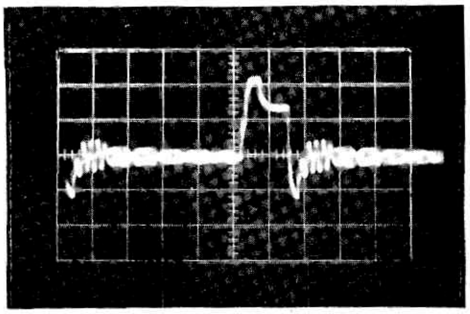


F. Reactance Tube Grid (TP2)
Amplitude: .5 volt/cm
Switch S1: Sync Tip
Switch S2: Mono

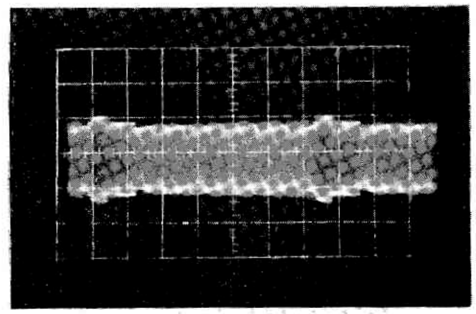


G. Gate Tube Grid (TP4)
Amplitude: 5 volts/cm
Switch S1: White Tip
Switch S2: Chrome

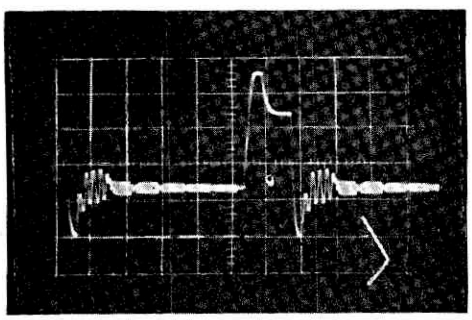
Figure MOD-4. Typical Waveforms



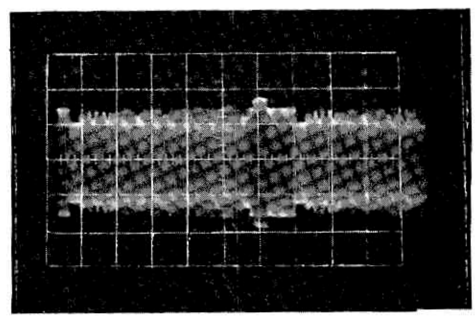
A. Gate Tube Grid (TP4)
Amplitude: 5 volts/cm
Switch S1: Sync Tip
Switch S2: Chrome



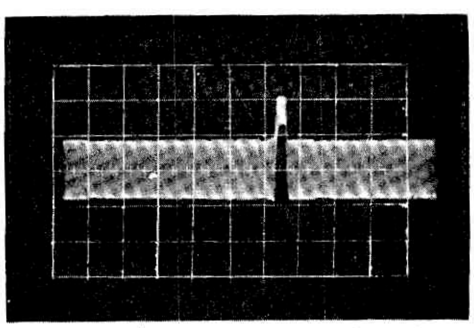
D. Tube V5 Plate (pin 5)
Amplitude: .1 volt/cm
Switch S1: Sync Tip
Switch S2: Mono



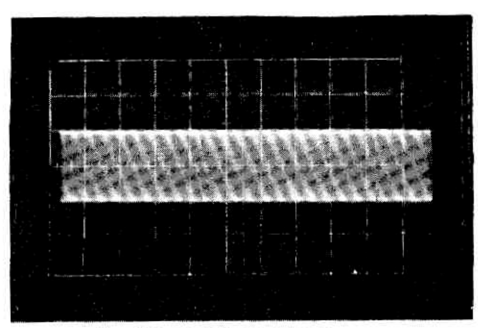
B. Gate Tube Grid (TP4)
Amplitude: 10 volts/cm
Switch S1: Sync Tip
Switch S2: Mono



E. Tube V8 Plate (pin 5)
Amplitude: .5 volt/cm
Switch S1: Sync Tip
Switch S2: Mono



C. Gate Tube Cathode (pin 3)
Amplitude: 2 volts/cm
Switch S1: Sync Tip
Switch S2: Mono



F. FM OUTPUT (TP3)
Amplitude: .5 volt/cm
Switch S1: Sync Tip
Switch S2: Mono

Figure MOD-5. Typical Waveforms

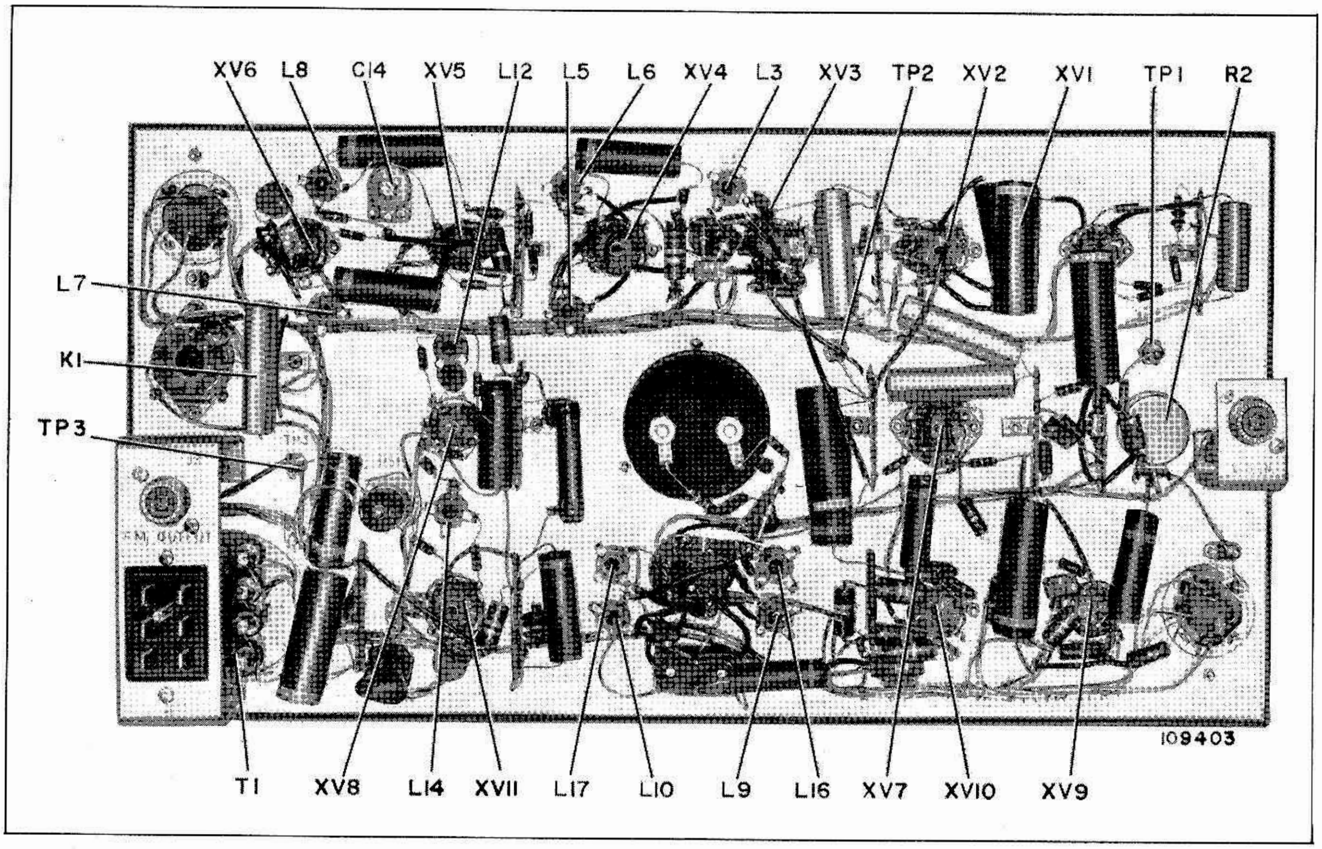


Figure MOD-6. Modulator, Rear View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			MODULATOR (8974476-502) 14
			CAPACITORS:
C1		727853-235	mica, 330 $\mu\mu$f ±5%, 500 v char "D"
C2		735715-83	paper, 0.47 μf ±10%, 200 v
C3A/D	98408	458558-5	electrolytic, 20/20/20/20 μf +50 -10%, 450 v
C4		735715-179	paper, 0.22 μf ±10%, 400 v
C5		735715-171	paper, 0.047 μf ±10%, 400 v
C6		735715-175	paper, 0.1 μf ±10%, 400 v
C7, C8		735715-179	paper, 0.22 μf ±10%, 400 v
C9		8811182-5	ceramic, 10,000 $\mu\mu$f +100 -20%, 450 v
C10			Not Used
C11		735715-175	paper, 0.1 μf ±10%, 400 v
C12		727853-107	mica, 22 $\mu\mu$f ±10%, 500 v char "D"
C13		8811182-7	ceramic, 1000 $\mu\mu$f +100 -20%, 500 v
C14	218162	984003-13	variable, ceramic, 8/50 $\mu\mu$f
C15		8811182-5	ceramic, 10,000 $\mu\mu$f +100 -20%, 450 v
C16		90575-303	ceramic, 5.6 $\mu\mu$f ±1 $\mu\mu$f, 500 v
C17		727851-125	mica, 120 $\mu\mu$f ±10%, 500 v char "B"
C18		735715-175	paper, 0.1 μf ±10%, 400 v
C19		735715-83	paper, 0.47 μf ±10%, 200 v
C20, C21		8811182-5	ceramic, 10,000 $\mu\mu$f +100 -20%, 450 v
C22A/D	98408	458558-5	electrolytic, 20/20/20/20 μf +50 -10%, 450 v

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
C23		727853-233	mica, 270 μμf ±5%, 500 v char "D"
C24		727853-237	mica, 390 μμf ±5%, 500 v char "D"
C25		735715-171	paper, 0.047 μf ±10%, 400 v
C26		735715-175	paper, 0.1 μf ±10%, 400 v
C27		727851-117	mica, 56 μμf ±10%, 500 v char "B"
C28		735715-171	paper, 0.047 μf ±10%, 400 v
C29		727853-107	mica, 22 μμf ±10%, 500 v char "D"
C30		735715-175	paper, 0.1 μf ±10%, 400 v
C31		8811182-7	ceramic, 1000 μμf +100 -20%, 500 v
C32		735715-175	paper, 0.1 μf ±10%, 400 v
C33		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C34		8811182-7	ceramic, 1000 μμf +100 -20%, 500 v
C35		735715-175	paper, 0.1 μf ±10%, 400 v
C36		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C37		735715-175	paper, 0.1 μf ±10%, 400 v
C38		735715-179	paper, 0.22 μf ±10%, 400 v
C39		727851-102	mica, 10 μμf ±10%, 500 v char "B"
C40		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C41			Not Used
C42		727853-231	mica, 220 μμf ±5%, 500 v char "D"
C43		727853-240	mica, 510 μμf ±5%, 300 v char "D"
C44		727853-231	mica, 220 μμf ±5%, 500 v char "D"
C45, C46		727851-117	mica, 56 μμf ±10%, 500 v char "B"
C47			Not Used
C48		727853-225	mica, 120 μμf ±5%, 500 v char "D"
CR1	99483		Diode: type 1N54A
DS1	101857	872291-9	Lamp: indicator
F1	53447	990157-108	Fuse: 1 amp, 250 v, slo-blo
J1	51604	727969-3	Connector: male, 6 contact, chassis mtg.
J2, J3	51800	255223-2	Connector: coax, chassis mtg.
K1	206744	460355-2	Relay: 24 v, D.C., DPDT
L1, L2	202910	8825473-505	Coil: choke, 10 microhenry
L3	219416	8979708-6	Coil: peaking
L4	209148	8825473-501	Coil: choke, 2 microhenry
L5	219417	8979708-2	Coil: peaking
L6	219418	8979708-3	Coil: peaking
L7	219419	8979708-4	Coil: peaking
L8	219420	8979708-5	Coil: peaking
L9, L10	211363	476933-1	Coil: peaking, 2/3 microhenry
L11	209148	8825473-501	Coil: choke, 2 microhenry
L12	213197	476933-3	Coil: peaking, 5/9 microhenry
L13	209148	8825473-501	Coil: choke, 2 microhenry
L14	210530	476933-4	Coil: peaking, 9/18 microhenry
L15	211179	8825473-523	Coil: choke, 200 microhenry
L16, L17	211363	476933-1	Coil: peaking, 2/3 microhenry
L18	99792	8825473-506	Coil: choke, 15 microhenry
M1	218164	484363-6	Meter: scale 0-1
P1	51607	727969-4	Connector: female, 6 contact, cable mtg.
P2, P3	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter: solder type
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		82283-136	110 ohm ±5%, ½ w
R2	99671	8971860-104	variable, comp, 250 ohm ±10%, 2 w
R3		82283-146	300 ohm ±5%, ½ w
R4		82283-152	510 ohm ±5%, ½ w
R5		82283-98	1 meg ±10%, ½ w
R6	45354	458572-77	wire wound, 10,000 ohm ±5%, 5 w
R7		82283-158	910 ohm ±5%, ½ w
R8, R9		82283-50	100 ohm ±10%, ½ w
R10		82283-98	1 meg ±10%, ½ w
R11		82283-158	910 ohm ±5%, ½ w
R12		82283-52	150 ohm ±10%, ½ w
R13		82283-98	1 meg ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R14	102241	458574-70	wire wound, 10,000 ohm, ±5%, 10 w
R15		82283-52	150 ohm ±10%, ½ w
R16		82283-63	1200 ohm ±10%, ½ w
R17		82283-209	120,000 ohm ±5%, ½ w
R18		82283-213	180,000 ohm ±5%, ½ w
R19		82283-46	47 ohm ±10%, ½ w
R20		99126-66	2200 ohm ±10%, 2 w
R21, R22			Not Used
R23, R24	96535	458574-62	wire wound, 5000 ohm ±5%, 10 w
R25		82283-60	680 ohm ±10%, ½ w
R26, R27		99126-84	68,000 ohm ±10%, 2 w
R28		82283-64	1500 ohm ±10%, ½ w
R29		82283-58	470 ohm ±10%, ½ w
R30	96214	458574-77	wire wound, 15,000 ohm ±5%, 10 w
R31		82283-98	1 meg ±10%, ½ w
R32		90496-83	56,000 ohm ±10%, 1 w
R33		99126-83	56,000 ohm ±10%, 2 w
R34		90496-74	10,000 ohm ±10%, 1 w
R35		82283-56	330 ohm ±10%, ½ w
R36			Not Used
R37		99126-83	56,000 ohm ±10%, 2 w
R38		90496-74	10,000 ohm ±10%, 1 w
R39		82283-82	47,000 ohm ±10%, ½ w
R40		82283-98	1 meg ±10%, ½ w
R41		82283-147	330 ohm ±5%, ½ w
R42 to R44		99126-84	68,000 ohm ±10%, 2 w
R45, R46		99126-74	10,000 ohm ±10%, 2 w
R47		82283-74	10,000 ohm ±10%, ½ w
R48		82283-98	1 meg ±10%, ½ w
R49, R50		82283-110	10 meg ±10%, ½ w
R51		82283-67	2700 ohm ±10%, ½ w
R52		82283-60	680 ohm ±10%, ½ w
R53, R54		99126-73	8200 ohm ±10%, 2 w
R55		82283-158	910 ohm ±5%, ½ w
R56		82283-49	82 ohm ±10%, ½ w
R57		82283-49	82 ohm ±10%, ½ w
R58		82283-82	47,000 ohm ±10%, ½ w
R59		82283-46	47 ohm ±10%, ½ w
R60		82283-50	100 ohm ±10%, ½ w
R61		82283-158	910 ohm ±10%, ½ w
R62		82283-49	82 ohm ±10%, ½ w
R63		82283-82	47,000 ohm ±10%, ½ w
R64		99126-77	18,000 ohm ±10%, 2 w
R65		82283-46	47 ohm ±10%, ½ w
R66	53749	8825410-71	wire wound, 4500 ohm ±10%, 10 w
R67		82283-49	82 ohm ±10%, ½ w
R68		82283-111	10 ohm ±5%, ½ w
R69			Part of XDS1
R70		82283-94	470,000 ohm ±10%, ½ w
R71		82283-61	820 ohm ±10%, ½ w
R72		82283-82	47,000 ohm ±10%, ½ w
R73		82283-84	68,000 ohm ±10%, ½ w
R74		82283-54	220 ohm ±10%, ½ w
R75		90496-212	160,000 ohm ±5%, 1 w
R76			Not Used
R77		82283-163	1500 ohm ±5%, ½ w
R78		82283-144	240 ohm ±5%, ½ w
R79, R89, R81			Not Used
R82		82283-152	510 ohms ±5%, ½ w
R83		82283-151	470 ohm ±5%, ½ w
R84		82283-150	430 ohm ±5%, ½ w
R85		82283-96	680,000 ohm ±10%, ½ w
R86		82283-155	680 ohm ±5%, ½ w
S1	93263	95559-5	Switch: toggle, DPDT

Symbol No.	Stock No.	Drawing No.	Description
S2	56584	8983928-1	Switch: rotary 4 pole 3 position
T1	58619	895326-4	Transformer: filament
TP1 to TP4	208983	8825493-7	Jack: tip
V3	219675		Tube: type 6922
XADS1	208080	990788-507	Lens: indicator light
XDS1	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XK1	68590	99100-4	Socket: relay
XV1	94925	737867-14	Socket: tube, 7 pin
XV2 to XV4	94926	737870-14	Socket: tube, 9 pin
XV5	94925	737867-14	Socket: tube, 7 pin
XV6, XV7	94926	737870-14	Socket: tube, 9 pin
XV8	94925	737867-14	Socket: tube, 7 pin
XV9 to XV11	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	34950	845607-1	Knob: black

ELECTRON TUBE VOLTAGE TABLE

Symbol	Type	Pin Numbers								
		1	2	3	4	5	6	7	8	9
V1	6CB6	1.3	2.7	Gnd	*6.3	123	136	Gnd	–	–
V2	6BQ7	92	0	1.25	*6.3	Gnd	110	8.4	12	Gnd
V3	6922	170	1.7	7.5	*6.3	Gnd	275	165	170	Gnd
V4	6BQ7A	28	Gnd	0	*6.3	Gnd	27	—0.4	–	Gnd
V5	6A56	0.9	1.7	Gnd	*6.3	94	98	—0.83	–	–
V6	6BQ7A	44	Gnd	0	*6.3	Gnd	34	—2.5	0	Gnd
V7	12AX7	0	—3.4	1.7	*6.3	*6.3	0	—3.4	1.7	Gnd
V8	6CB6	0	0.95	Gnd	*6.3	270	100	–	–	–
V9	6BQ7A	45	—0.1	0.8	*6.3	Gnd	22	0.12	Gnd	Gnd
V10	6BQ7A	60	—25	4	*6.3	Gnd	100	—0.95	Gnd	Gnd
V11	6CL6	2.8	0	140	*6.3	Gnd	170	Gnd	–	–

NOTE 1: All voltages are dc except those preceded by an asterisk.

NOTE 2: The voltage readings were taken under the following conditions: Input voltage to modulator 1.0 volt peak-to-peak; Switch S1 in SYNC TIP position; switch S2 in MONO position.

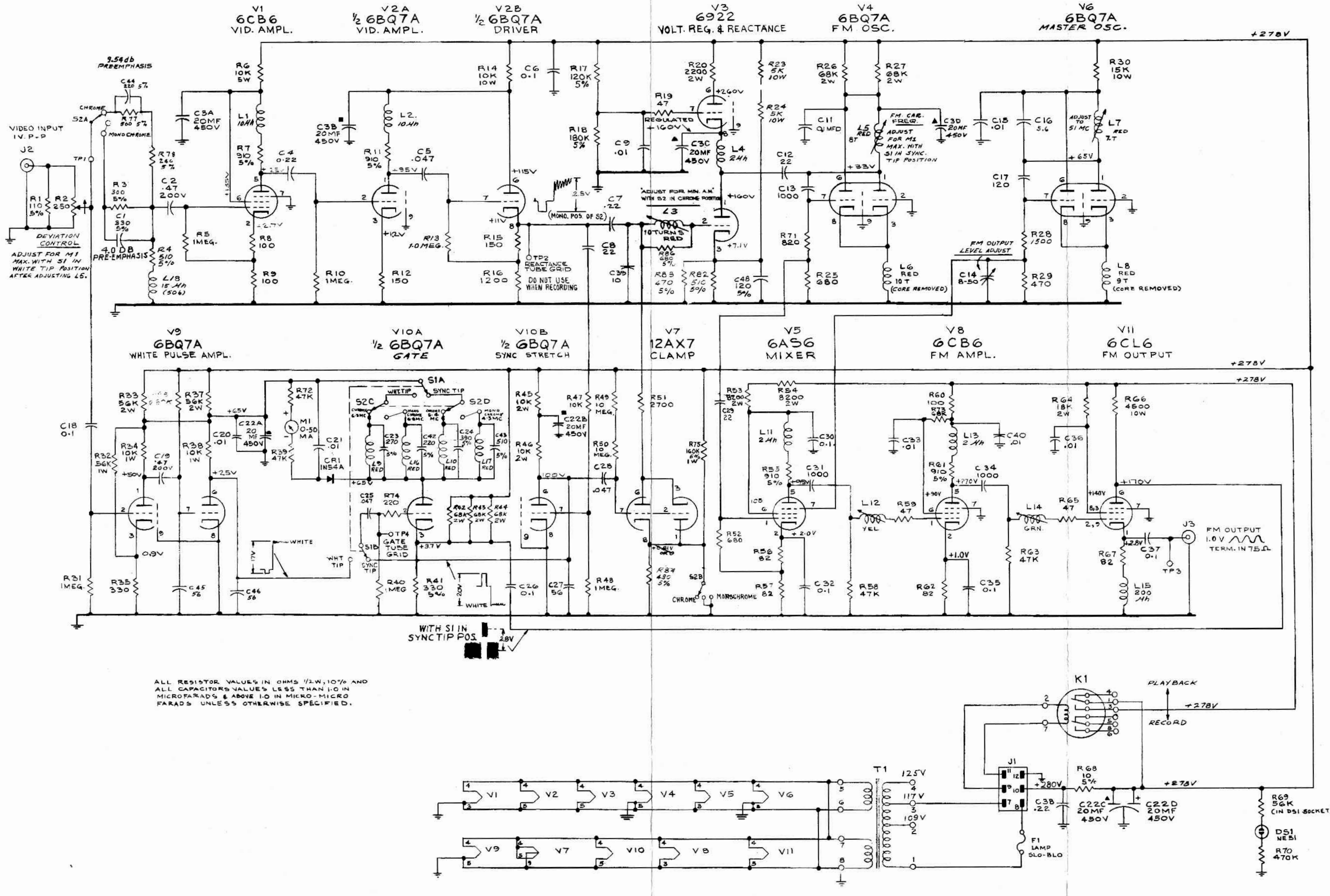


Figure MOD-7. Modulator Schematic Diagram

ELECTRONIC RECORDING PRODUCTS

Picture Monitor*

UNIT 103

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

* Same as TM-7BR

IB-31125

PRINTED IN U.S.A.
WA 641

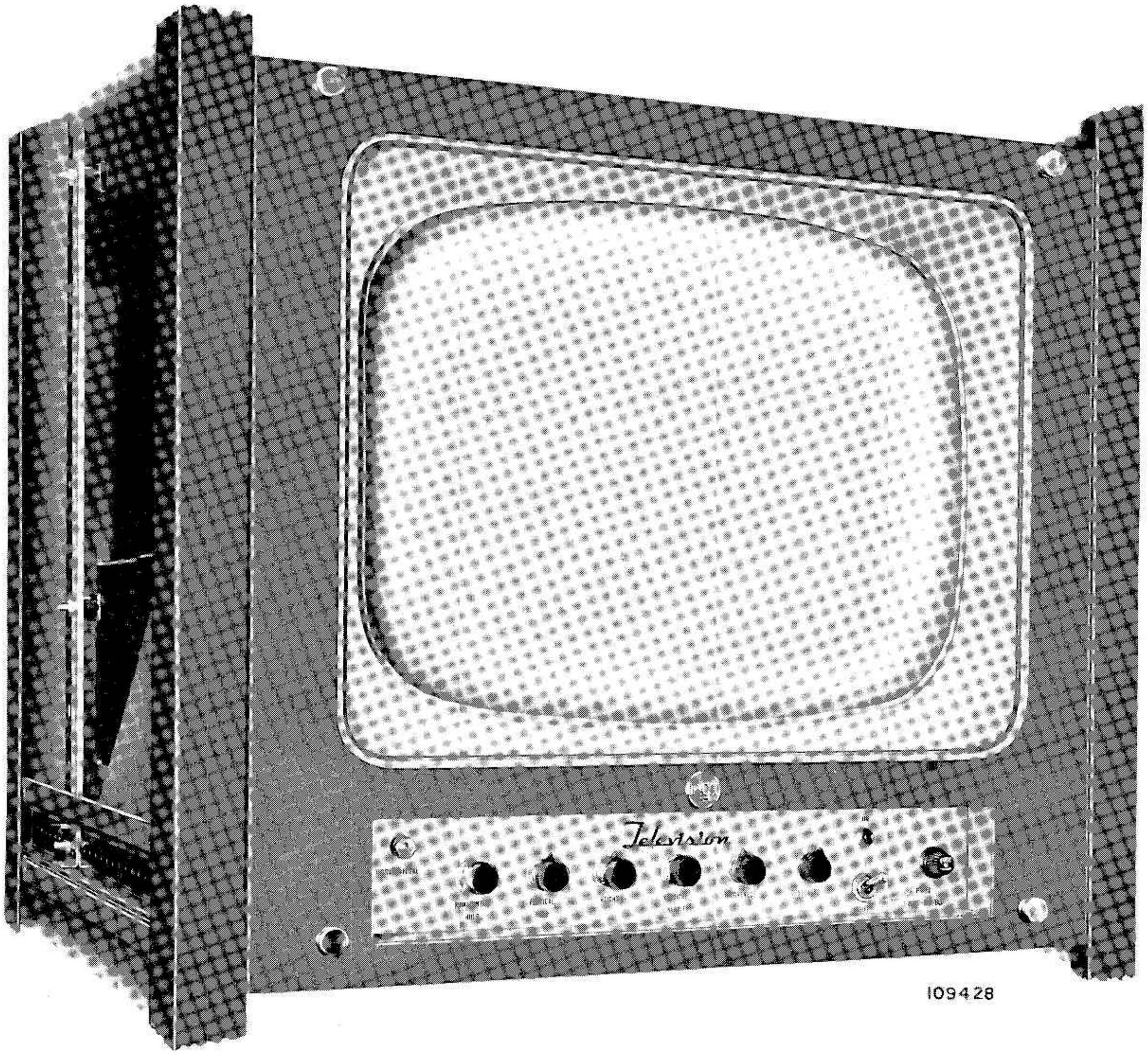


Figure PM-1. Picture Monitor

TECHNICAL DATA

Power Required

115 volts AC, 60 cycles, 125 watts from C.B. #1

Internal Sync Operation

Nominal 1.0 volt, peak-to-peak composite video

External Sync Operation

Nominal 4.0 volt, peak-to-peak sync required (Used to check Tone Wheel Synchronization)

Frequency Response

Flat ±1 db to 10 mc

Tube Complement

1	12BY7	1	6AY4GTA
1	6AN8	1	6DQ6
1	12AT7	2	6AU6
1	6AQ5	3	6CG7
1	1B3GT	1	17BP4B

DESCRIPTION

The Picture Monitor, unit 103, with 17-inch kinescope and all tubes in place, is mounted near the top of Rack 1. This is a general purpose, self-contained video monitor.

In this system, the monitor is connected to 115 vac for normal scanning and operated with a composite video input signal. This signal is connected to J1; the unused jack J2 is terminated in 75 ohms. An external sync signal, controlled by the Sync Interlock Relay K1, is used for checking the Tone Wheel synchronization and is also used with a non-composite video signal, if desired. Underscanning to allow viewing of the raster corners is also available.

The Picture Monitor provides a convenient means for checking the performance of the system at various points. These procedures are given in detail in the overall system instruction book. Two spare pushbuttons are available for other monitoring applications. The monitoring video input is connected to the CRO Monitor Switcher, unit 307, Rack 3. The signal for monitoring is selected by a row of Monitor pushbuttons, designated as follows:

VIDEO INPUT	DEMOD OUT	LINE OUT	SPARE	SPARE	TONE WHEEL
J1	J2	J3	J4	J5	J9

To check system performance, the following signals may be monitored:

Signal to be Monitored	*Signal Source*	*Pushbutton Designation*	*Type of Sync*
System Video Signal Input	Distribution Amplifier #1 (304)	VID INPUT	INT
Demod Video Signal Output	Distribution Amplifier #2 (303)	DEMOD OUT	INT
System Line Output	Video Processing Amplifier (308)	LINE OUT	INT
Tone Wheel Synchronization	Tone Wheel Amplifier (505)	TONE WHEEL	EXT

Circuit Description

The video signal from the input jack is amplified in the video amplifier V1 and V2 and coupled to the video output amplifier V3. The signal from the output amplifier is fed to the sync separator V4B and also applied to the cathode of the kinescope V5. DC restoration is accomplished at the kinescope cathode by means of the d-c restorer 4VA, which may be switched in (normally used in this position) or out of the circuit by the D.C. REST. switch S1, located on the rear apron of the chassis. The sync amplifier V6 obtains its signal through relay K1 from the sync separator V4B or from the external sync signal appearing at J3 (or J4) depending upon the type of operation desired. The signal appearing at the plate, pin 6, of V6 is integrated by the vertical integrator PC101 and fed to the sawtooth generator V7. The signal appearing at the plate, pin 1, of V6 is fed to the horizontal control tube V9A.

The output of the vertical sawtooth generator is coupled to the vertical output amplifier V8. By use of feedback, the linearity of this stage is optimized and the signal is then applied to the vertical windings of the deflection yoke.

The horizontal control signal from V9A is coupled to the horizontal oscillator V9B which generates a sawtooth waveform to drive the horizontal output tube V10. The damper tube V12, which is connected across a portion of the horizontal output transformer T3, conducts the horizontal sweep current during the first third of the sweep cycle. The horizontal output transformer which can be connected for normal or underscan operation, couples the sweep current to the horizontal windings of the yoke and also couples flyback energy to the high voltage rectifier V11. The kinescope ultor voltage is developed by V11.

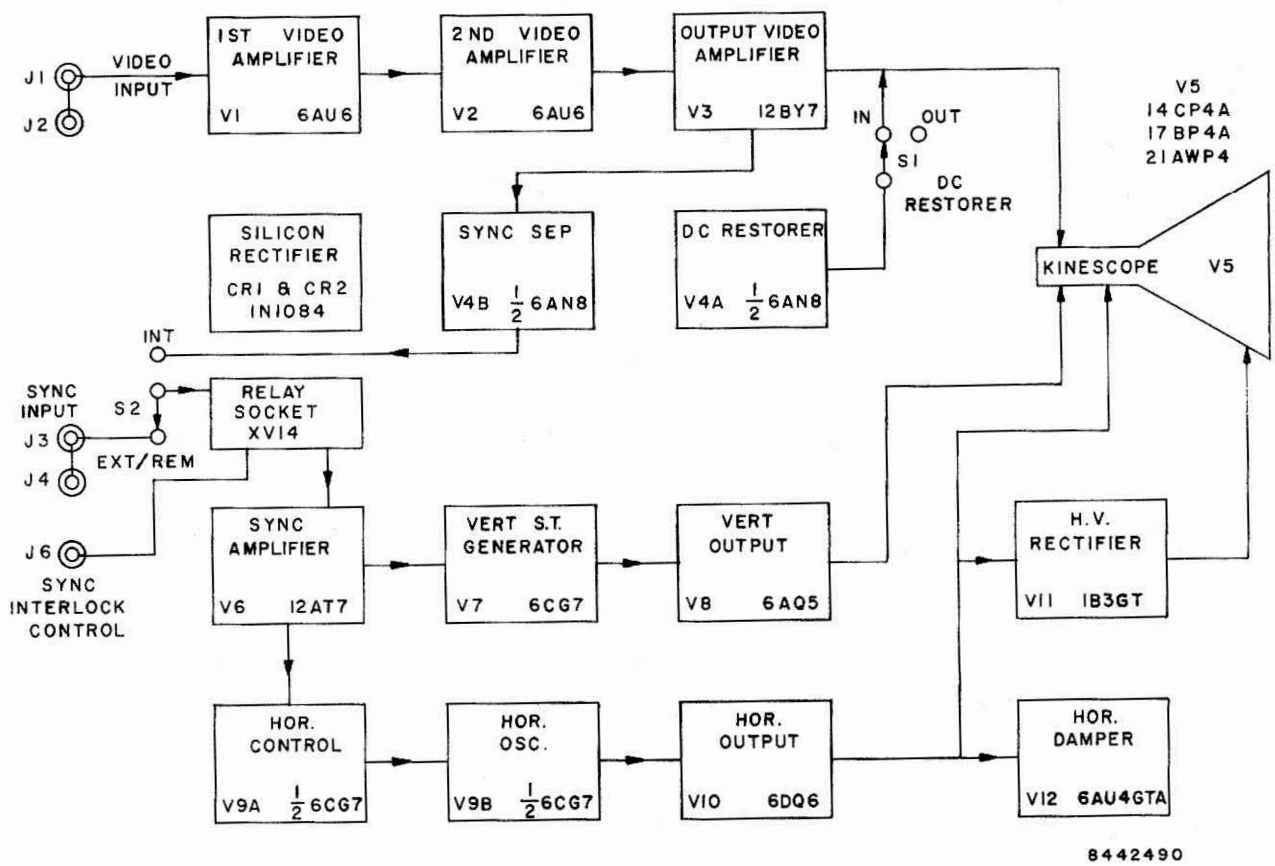


Figure PM-2. Block Diagram

INSTALLATION

The Picture Monitor is shipped installed in Rack 1. The monitor is connected for use with external sync with the relay K1 plugged in the socket XV14.

To operate from the external sync, switch S2 is placed in the EXT/REM position. EXT SYNC J3 is connected to J12, MON SYNC OUT on the Reference Generator, unit 407. In this system, the selection of internal or external sync as required is controlled automatically from the CRO Monitor Switcher, unit 307. When the relay K1 is energized, (J6 is grounded), the monitor operates from internal sync. When relay K1 is deenergized, the monitor operates from external sync. The AUX BRIGHTNESS control R37 is part of the Sync Interlock Circuit. Proper adjustment of this control when using external sync provides constant background brightness levels when switching between composite and non-composite video signals.

Underscan operation of the monitor is available if desired.

CAUTION: Make sure the monitor a-c power is turned off and that the high voltage is discharged before proceeding with the underscan procedure.

a. Disconnect the lead found on T3-6 and reconnect it to T3-2.

b. Disconnect the lead found on T3-3 and reconnect it to T3-1.

c. Turn on the AC power and allow the monitor to warm up.

d. Readjust the horizontal and vertical linearity and width controls to obtain more or less underscan as desired.

OPERATION

The monitor is shipped mounted in Rack 1 with all connections and adjustments made. The identification and function of all controls on the monitor have been tabulated in the following chart for convenient reference:

Proper adjustment of the CONTRAST control depends upon the incoming video signal level. The BRIGHTNESS control should normally be adjusted in conjunction with the CONTRAST control so that the black areas of the picture are at the kinescope cutoff voltage. This condition exists when no scanning lines can be observed in the picture blacks. If the picture being viewed contains no black areas, the blanking level may be used as a reference. Adjust the HORIZ HOLD and VERT HOLD controls until the picture is in sync. Then adjust the BRIGHTNESS control for the desired brightness.

CONTROL CHART

Panel Designation	*Symbol Number*	*Function*
Front Panel		
HOR. DRIVE	C40	CW adjustment to point just below the position causing one or more drive bars to appear in raster.
HORIZ HOLD	R74	Adjust sync of picture horizontally.
VERT HOLD	R52	Adjust sync of picture vertically.
HEIGHT	R61	Adjust for desired height of raster.
VERT LIN	R59	Adjust for desired vertical linearity of raster.
BRIGHTNESS	R36	CCW to obtain normal background level; adjust in conjunction with CONTRAST.
CONTRAST	R5	Adjust with BRIGHTNESS; refer to conditions p. PM-5.
ON-OFF	S3	AC power.
Chassis Mounted		
VERT FEEDBACK	R54	Adjust with HEIGHT and VERT LIN to obtain optimum vertical linearity.
HOR STABILITY	Part of T2	Adjust so that waveform appearing at terminal C of T2 appears as shown in figure PM-5E.
Rear Apron		
AC UTILITY OUTLET	J8	Convenience.
AUX BRIGHTNESS	R37	Adjust to obtain the same brightness level when switching video signals with or without sync; part of Sync Interlocking Circuit.
VIDEO INPUT	J1, J2	Composite or non-composite video signal; J2 terminated in 75 ohms or looped through to other equipment.
SYNC INPUT	J3, J4	External sync signal; J4 terminated or looped through; for this system, external sync from Reference Generator to J3.
OUT/IN DC REST	S1	Switches d-c restorer V4A in or out of the circuit.
INT-EXT/REM	S2	Selects external or internal sync according to the application.
SYNC INT	J6	Phono pin jack for phone plug P6 when connected to a grounding switch at the monitor or remote.
WIDTH	L9	Screwdriver adjustment so that raster fills entire screen.
HORIZ LIN	L10	Screwdriver adjustment to obtain best linearity.

MAINTENANCE

WARNING

THE VOLTAGES EMPLOYED IN THIS EQUIPMENT ARE SUFFICIENTLY HIGH TO ENDANGER LIFE. MAKE CERTAIN POWER IS OFF AND CAPACITORS ARE DISCHARGED BEFORE TOUCHING ANY COMPONENT.

The picture monitor has been conservatively designed for continuous operation. With ordinary care a minimum of service will be required to keep the equipment in a satisfactory operating condition. To avoid interruptions due to equipment failure, a regular schedule of inspection should be established.

The monitor should be cleaned and dusted thoroughly during inspection periods. All cable connections should be checked periodically and tightened when necessary. Make certain all ground connections are tight.

Periodically check all tubes in the equipment and record the results in previously prepared forms. As far as possible, tube failure should be anticipated by reference to the tube log. Spare tubes should be available in the event of an obvious failure.

To Replace Kinescope

The monitor is shipped with the kinescope and all tubes in place. The basic procedure outlined below can be used to remove and replace a kinescope:

CAUTION: Handle the kinescope at the corners near the front of the tube. Do not apply pressure on the neck of the tube. Shatter proof glasses and heavy gloves should be worn. Persons not so equipped should be kept at a safe distance from the tube being handled.

1. Remove all interconnecting cables from the jacks.

2. Remove the monitor chassis from the rack mounting.

3. Observe the precaution necessary for removing the kinescope.

4. Remove the kinescope socket, ion trap and mounting strap.

5. Remove the kinescope.

6. Follow this procedure in reverse when installing the new kinescope. The ion trap must be adjusted before the back cover is replaced. Refer to *Alignment* for the procedures to be followed after replacing a tube or component.

Alignment

When a component has been replaced in the Picture Monitor, one or more of the following adjustments may be necessary with the monitor connected for normal scan:

1. *Ion-Trap Magnet*

a. Apply power to the monitor and allow the tubes to reach operating temperature.

b. Rotate the BRIGHTNESS control to its maximum clockwise position.

c. Adjust the ion-trap magnet for maximum brightness of the raster.

d. Synchronize the raster by means of the HORIZ HOLD and VERT HOLD controls, (if necessary).

e. Rotate the BRIGHTNESS control counterclockwise until a raster of the desired brightness is obtained.

f. Readjust the ion-trap magnet for a maximum brightness.

2. *Yoke Positioning*

In order for the deflection yoke to operate properly, it must ride the neck and bell of the kinescope so that it sits as close to the face of the kinescope as possible. If necessary, loosen the wing screw securing the yoke in its mounting and push the yoke forward as far as possible. Should the yoke need to be moved further, loosen the screws holding the deflection and focusing assembly to the chassis and slide the assembly toward the front of the chassis. When sufficient distance has been obtained, tighten the assembly to the chassis again. Rotate the yoke as needed until the scanning lines are horizontal. Tighten the wing screw.

3. *Centering*

a. Turn the ac power on and allow the monitor to warm up.

b. Loosen the centering adjustment locking lever located on the focus magnet mounting.

c. Center the raster by re-positioning the omnidirectional centering adjustment. Proper centering will result in a raster free of neck shadows.

d. Tighten the locking lever. (The raster may have to be recentered after optimum horizontal and vertical linearity are obtained.)

4. *Horizontal Drive*

The HORizontal DRIVE control, C40, should be adjusted in a clockwise direction to a point just below the position that causes one or more "drive bars" to

appear in the raster. A drive bar appears as a bright vertical line near the center of the raster.

5. *Focus*

To obtain best focus adjust the knurled and slotted knob located at the rear of the focus-deflection assembly and parallel to the neck of the kinescope.

6. *Vertical Linearity*

a. Adjust the HEIGHT and VERTical LINearity controls for the desired height and vertical linearity.

b. In conjunction with the two controls in step a, adjust the VERTical FEEDback for minimum foldover or compression at the top of the raster and thus optimum vertical linearity.

7. *Width and Horizontal Linearity*

a. Adjust the WIDTH control, L9, on the rear wall of the high voltage compartment so that the raster fills the entire screen as desired.

b. Adjust the HORIZontal LINearity control, L10, also located on the rear wall of the high voltage compartment, for the best linearity.

NOTE: In order to obtain the best overall linearity it may be necessary to go back and touch up all controls. Also, when the monitor is connected for underscan (see INSTALLATION) all controls may once again need retouching for best linearity.

8. *Auxiliary Brightness Control*

a. Place the INT-EXT/REM switch, S2, on the rear apron, in the INT position.

b. Apply a video signal with sync to the video input jack, J1 or J2, terminating the unused jack. Adjust the BRIGHTNESS control, R36, for a normal background level.

c. Place the INT-EXT/REM switch, S2, in the EXT/REM position and apply a video signal without sync but of the same level as the video portion of the signal applied in step b.

d. Apply a sync signal to the SYNC input jack, J3 or J4, terminating the unused jack.

e. Adjust the AUXiliary BRIGHTNESS control R37, for the same background level as that in step b.

If the AUXiliary BRIGHTNESS control is properly adjusted, the same brightness level will result when switching video signals with or without sync.

The Sync Interlock feature is used in this system; therefore, relay K1 must be plugged into the socket XV14 and the INT-EXT/REM switch S2, must be in the EXT/REM position. Grounding of the center conductor of the Phono-Jack J6, allows the relay to switch internal or external sync to the monitor as selected by the pushbuttons on the CRO Monitor Switcher.

Trouble Shooting

When faulty monitor operation occurs, check the fuses, tubes, power input and signal inputs, and setting of the BRIGHTNESS control.

Representative waveforms for all circuits are shown in figures PM-3 through PM-5. Also shown in these figures are typical peak-to-peak voltages. Reference to these waveforms will assist in locating faulty circuits and components. A block diagram and schematic diagram are shown in figures PM-2 and PM-9 respectively. For circuit checking, see the bottom view of the monitor, figure PM-8.

Service Adjustments

1. *Horizontal Oscillator Adjustment*

With an input sync signal of nominal value (station standard sync amplitude on a composite signal if internal sync is used, or 4 volts of sync, if external sync is used) the horizontal frequency control will synchronize the raster horizontally when the HORIZontal HOLD control is properly adjusted. Be sure the monitor has had a 20 minute warm-up period before making this adjustment.

The HOR STABILITY adjustment (part of T2) should be such that the waveform appearing at terminal C of T2 appears as shown in figure 5E. Using a high impedance probe, observe this waveform. The picture should be synchronized horizontally with the HORIZ HOLD control while this adjustment is being made. The criterion of this adjustment is that the broad and sharp positive peaks of the waveform be at the same level as shown in figure 5E.

2. *Frequency Response Adjustment*

Variable peaking coils (L2, L3, L5 and L6) are provided in the video amplifier for adjusting the amplitude frequency response when using a video sweep generator, a diode detector and an oscilloscope. Feed the generator into the VID INPUT J1 and place a low capacity probe (42 mmf) at the cathodes of V5, pin 11. When adjusted, the frequency response should be flat within ± 1 db at 10 mc.

Since tube replacement in the video amplifier will probably have no appreciable effect on picture resolution of 0 —4, it should not normally be necessary to re-adjust the peaking coils.

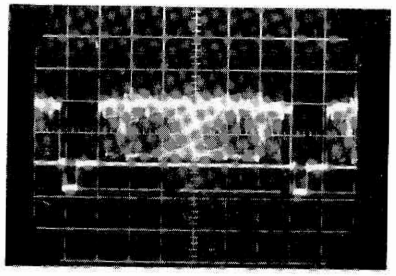
TYPICAL SOCKET VOLTAGES

Tube Symbol	Tube Function	Tube Type	Plate Pin No.	Plate Volts DC	Cathode Pin No.	Cathode Volts DC	Grid Pin No.	Grid Volts DC	Screen Pin No.	Screen Volts DC	Suppressor Pin No.	Suppressor Volts DC	Filament Pin No.	Filament Volts AC
V1	Video Amplifier	6AU6	5	133	7	18.0	1	4.0	6	140	2	0	3-4	6.3
V2	Video Amplifier	6AU6	5	240	7	17.2	1	12.0	6	146	2	0	3-4	6.3
V3	Video Output	12BY7	7	200	1	3.7	2	1.8	8	145	3	0	4,5-6	6.3
V4	D.C.Restorer	6AN8	1	83	3	97	2	83	7	54	-	-	4-5	6.3
			6	142	9	0	8	-12						
V5	Kinescope	14CP4A 17BP4A 21AWP4	-	-	11	83	2	20	10	377	-	-	1-12	6.3
V6	Sync Amplifier	12AT7	1	241	3	94	2	92	-	-	-	-	4,5-9	6.3
			6	252	8	94	7	92						
V7	Vertical Sawtooth Generator	6CG7	1	80	3	2.8	2	-.05	-	-	-	-	4-5	6.3
			6	31.5	8	2.8	7	-9.5						
V8	Vertical Output	6AQ5	5	250	2	18.1	1	.05	6	256	-	-	3-4	6.3
V9	Horizontal Control and Osc.	6CG7	1	98	3	- 1.1	2	-18.6	-	-	-	-	4-5	6.3
			6	144	8	0	7	-58.5						
V10	Horizontal Output	6DQ6	Do NOT MEASURE		8	0	5	-28	4	144	-	-	2-7	6.3
V11	H.V. Rectifier	1B3GT	DO NOT MEASURE											
V12	Damper	6AU4	5	255	3	600	-	-	-	-	-	-	7-8	6.3

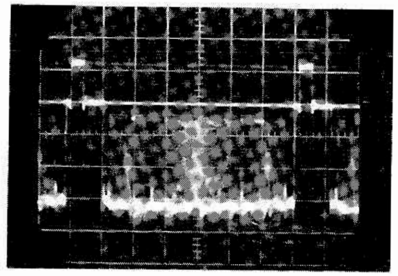
CONDITIONS:

No Video Signal.
Switch S1 - IN.
Switch S2 - INT.
Measured with RCA Senior VoltOhmyst, WV-98A, from pin to gnd.

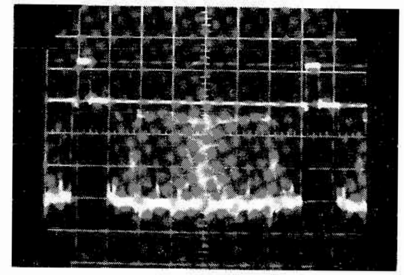
Figure PM-3. Representative Waveforms



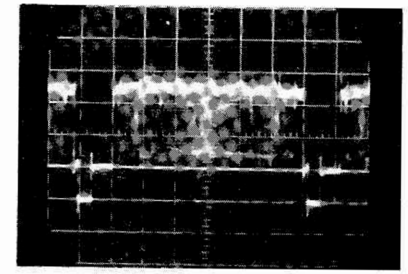
1. Grid of Video Amplifier; V1-1, 1.4 v p-p



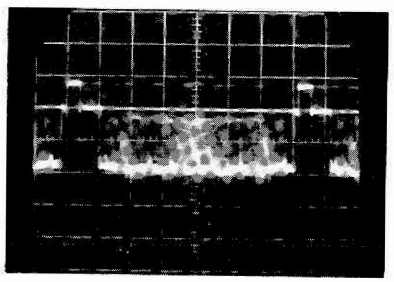
2. Plate of Video Amplifier; V1-5, 2.3 v p-p



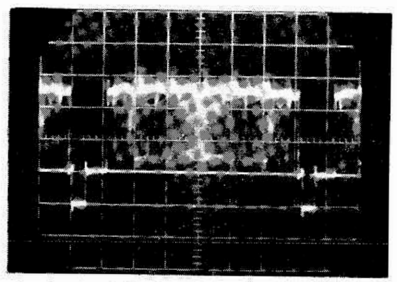
3. Grid of Video Amplifier; V2-1, 2.3 v p-p



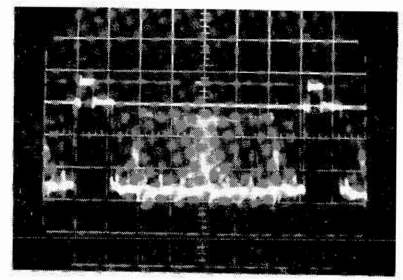
4. Plate of Video Amplifier; V2-5, 3.7 v p-p



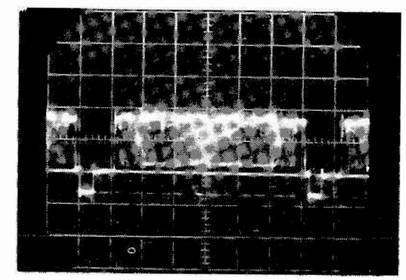
5. Cathode of Video Amplifier; V2-7, 1.4 v p-p



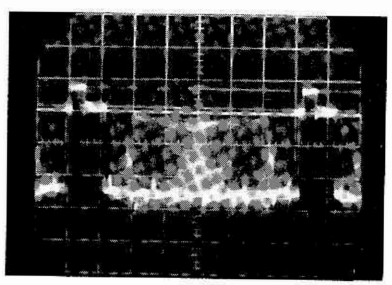
6. Grid of Video Output Amplifier; V3-2, 3.7 v p-p



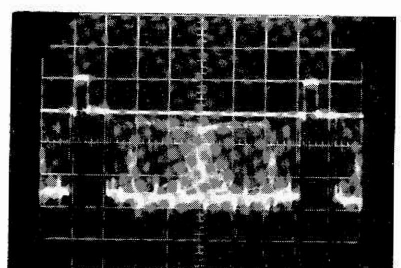
7. Plate of Video Output Amplifier; V3-7, 34 v p-p



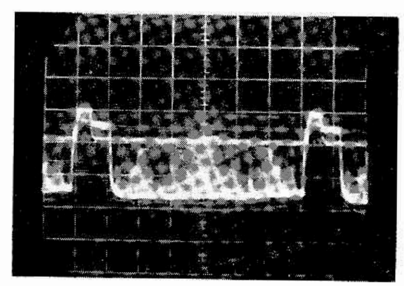
8. Cathode of Video Output Amplifier; V3-1, 2.6 v p-p



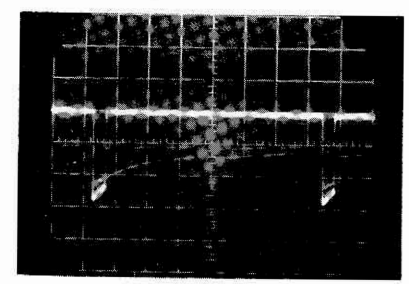
9. Cathode of Kinescope; V5-11, 34 v p-p, DC restorer in



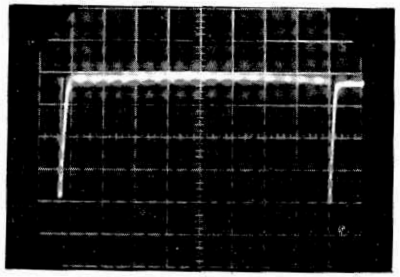
10. Cathode of Kinescope; V5-11, 37 v p-p, DC restorer out



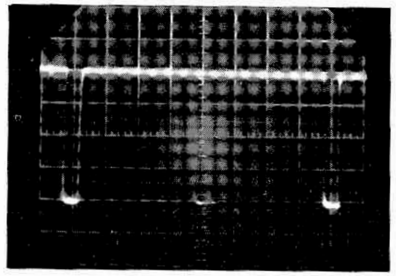
11. Grid of Sync Separator; V4B-8, 28 v p-p



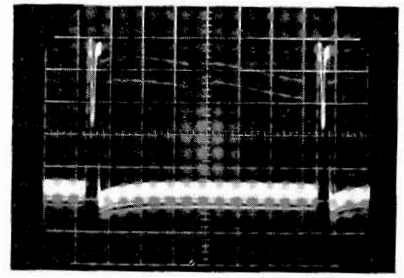
12. Plate of Sync Separator; V4B-6, 5.6 v p-p



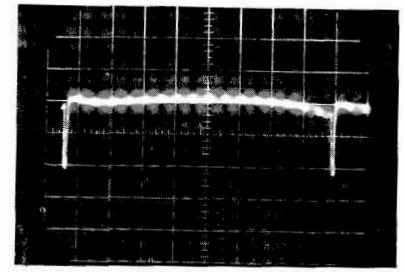
A Control Grid of Kinescope; V5-2 19 v p-p



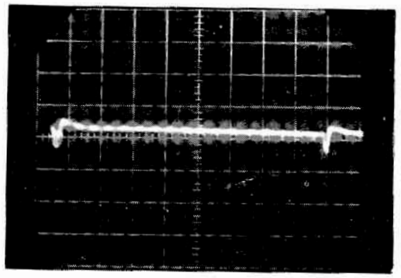
B Sync In Jack, 4 v p-p



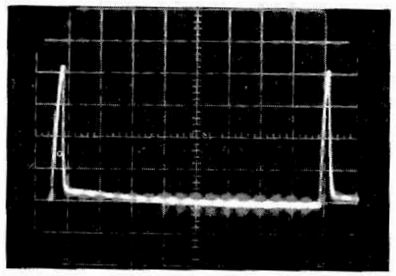
C Plate of Sync Amplifier; V6-1, 10 v p-p



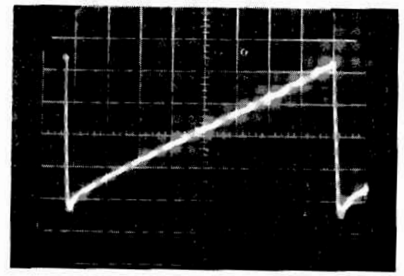
D Plate of Sync Amplifier; V6-6, 2.2 v p-p



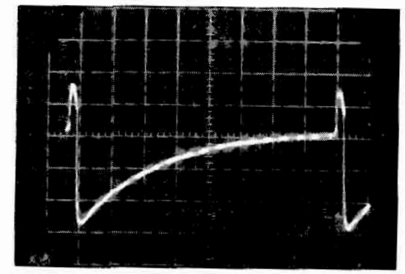
E Grid of Vertical Sawtooth Generator; V7-2, 0.3 v p-p



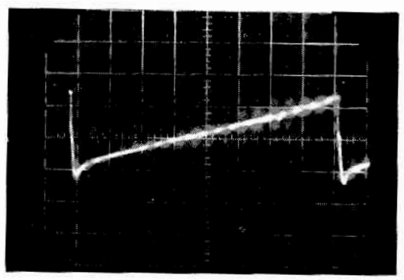
F Plate of Vertical Sawtooth Generator; V7-1, 43 v p-p



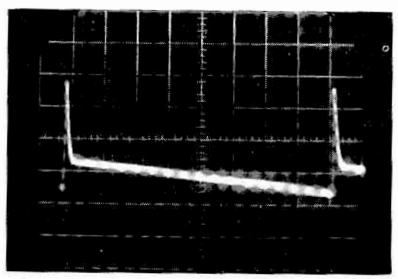
G Plate of Vertical Sawtooth Generator; V7-6, 48 v p-p



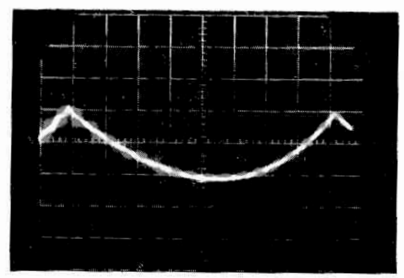
H Grid of Vertical Sawtooth Generator; V7-7, 14 v p-p



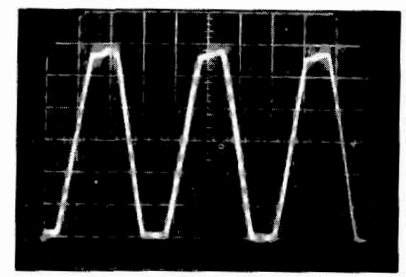
I Grid of Vertical Output Amplifier; V8-1, 28 v p-p



J Plate of Vertical Output Amplifier; V8-5, 680 v p-p

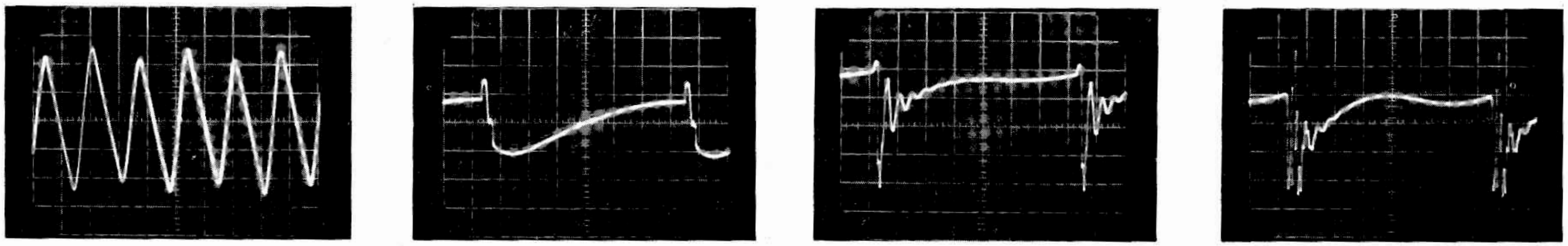


K Cathode of Vertical Output Amplifier; V8-2, 1.7 v p-p



L Junction of Diodes CR1 and CR2; 290 v p-p

Figure PM-4. Representative Waveforms

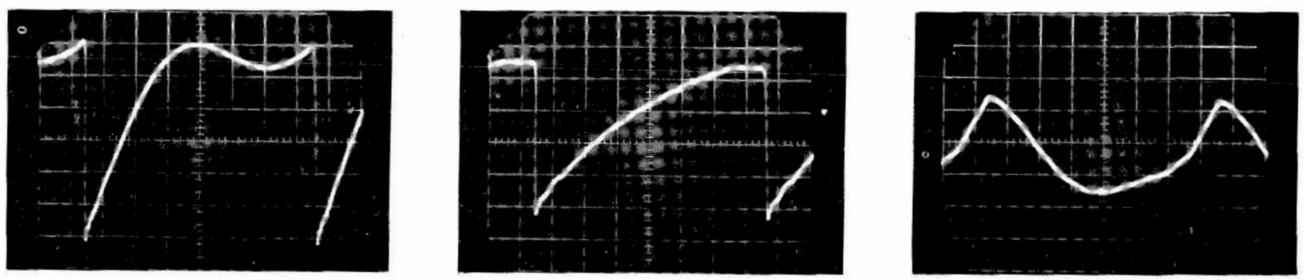


A Junction of Diode CR2 and Filter Choke L8; 100 v p-p

B Grid of Horizontal Control Tube; V9A-2, 28 v p-p

C Grid of Horizontal Oscillator; V9B-7, 450 v p-p

D Plate of Horizontal Oscillator; V9B-6, 250 v p-p



E Terminal C of Synchroguide Transformer; T2-C, 125 v p-p

F Grid of Horizontal Output Amplifier; V10-5, 96 v p-p

G Plate of Damper Tube; V12-5, 145 v p-p

Figure PM-5. Representative Waveforms

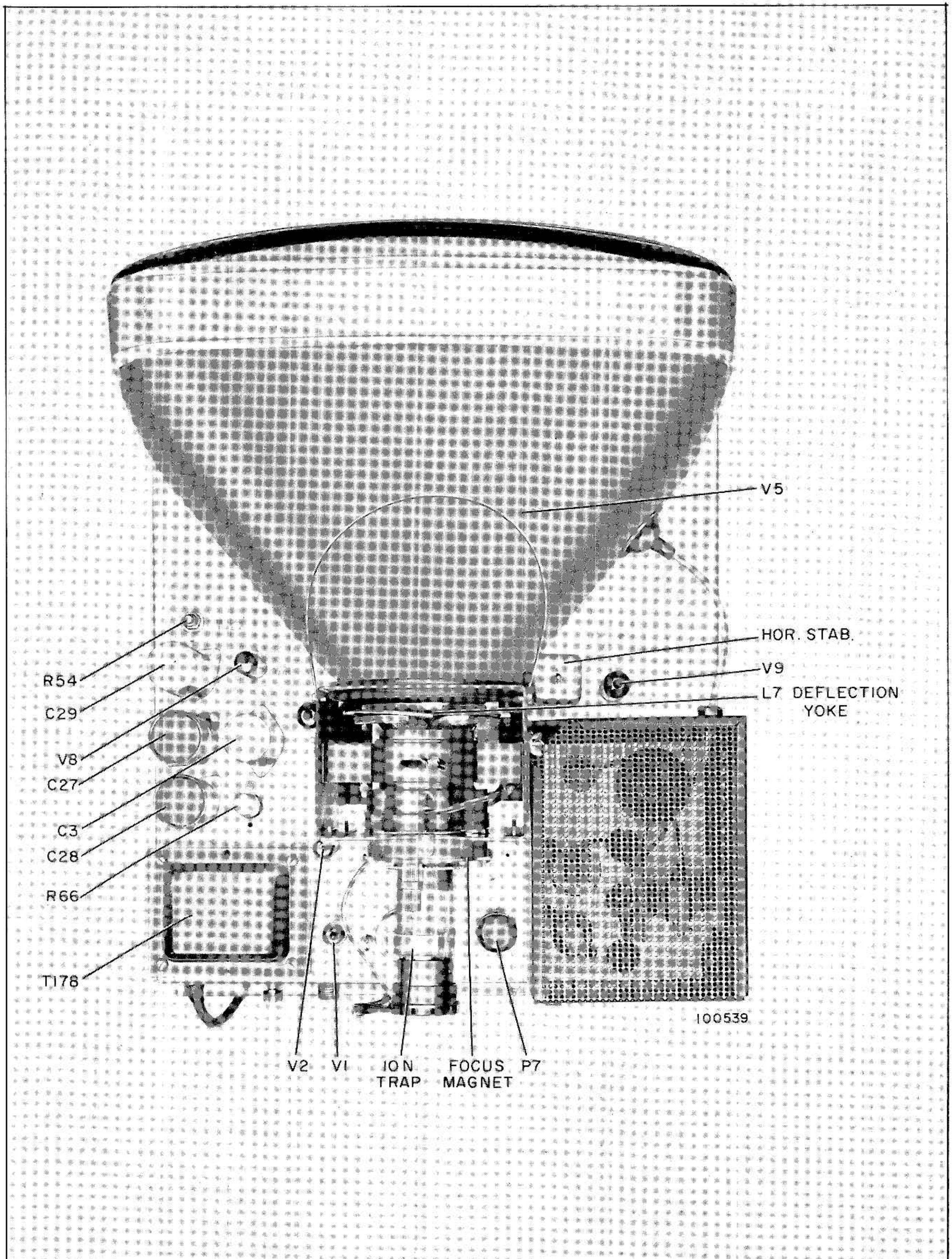


Figure PM-6. Picture Monitor (Rear View)

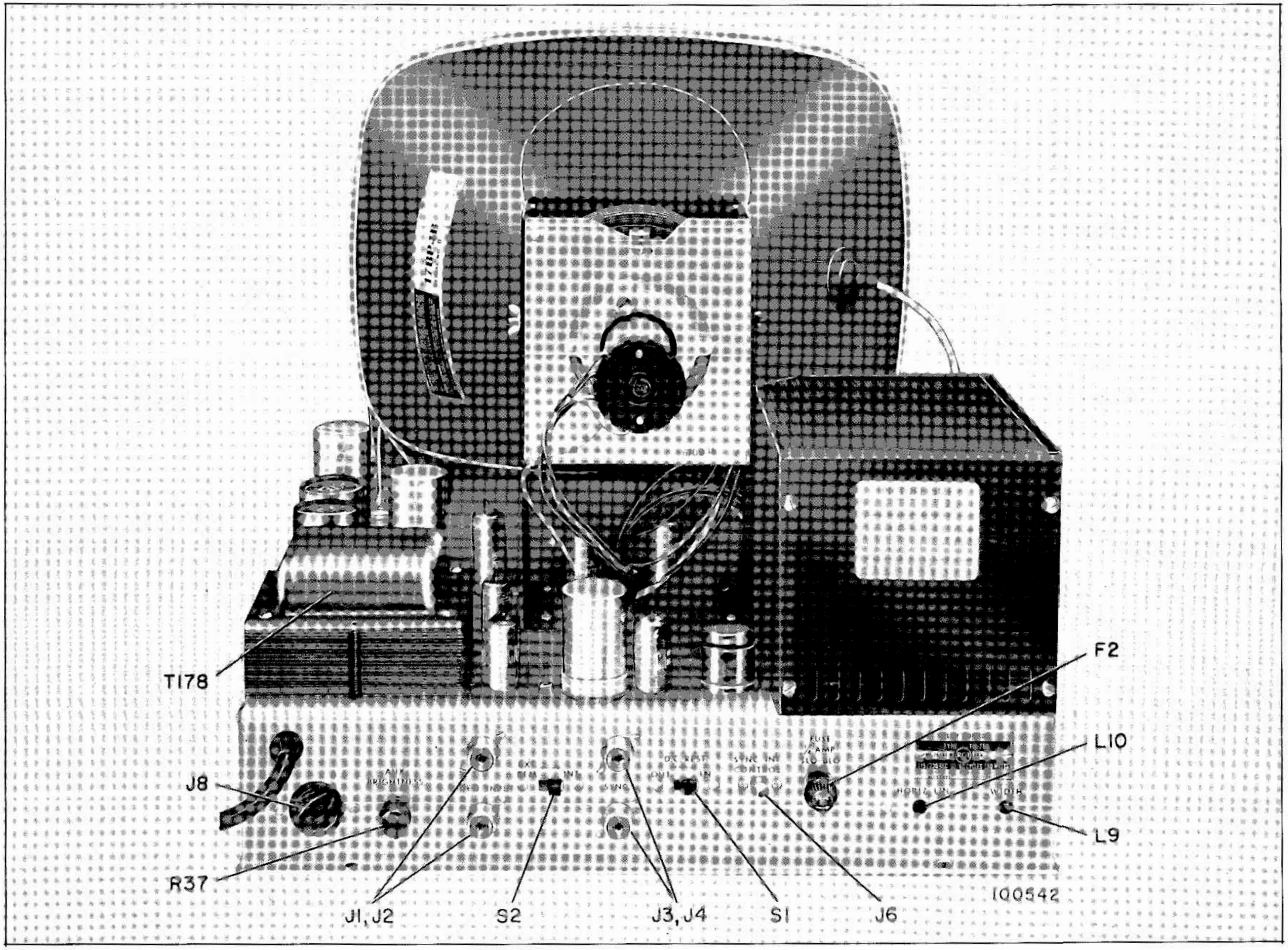


Figure PM-7. Picture Monitor (Top View)

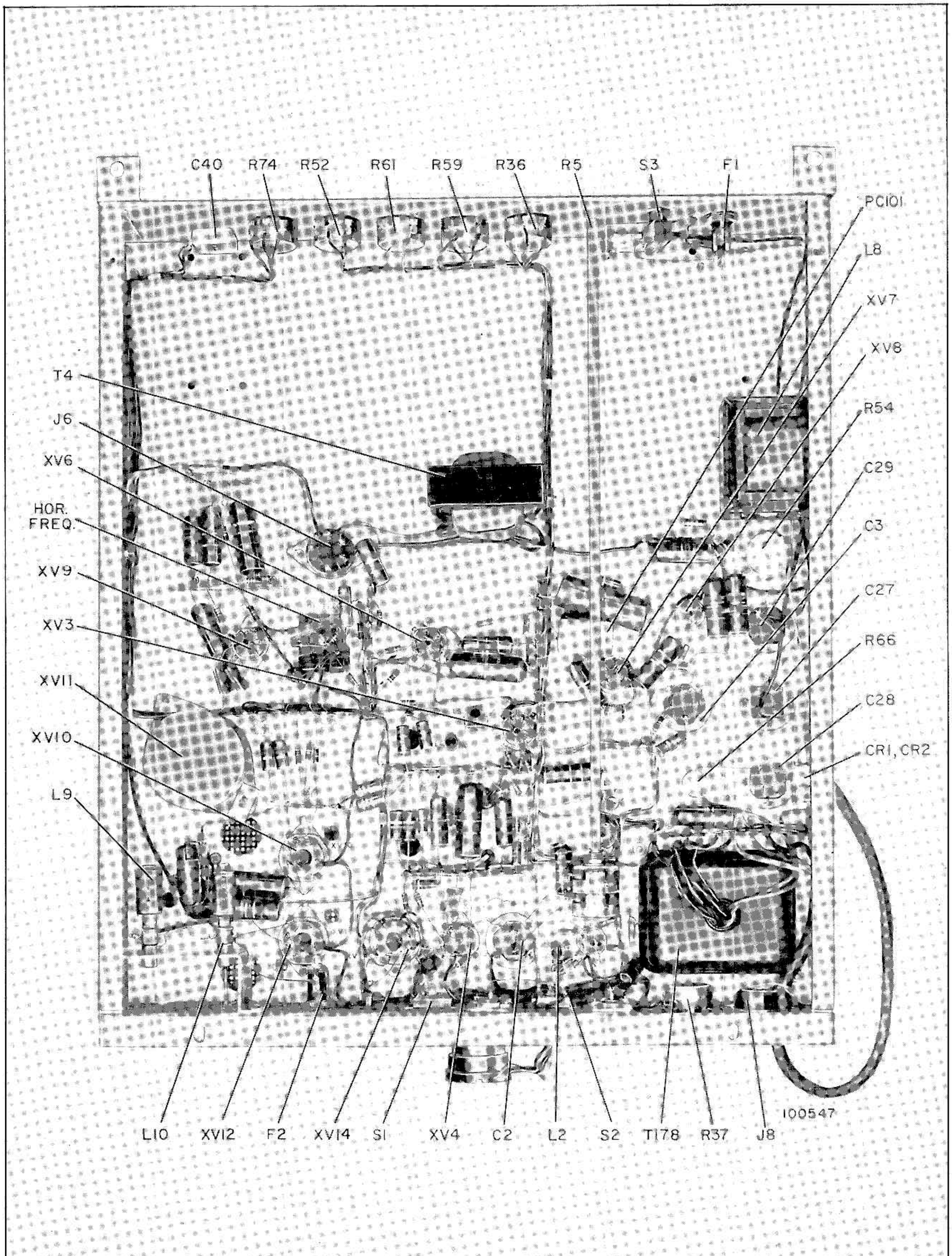


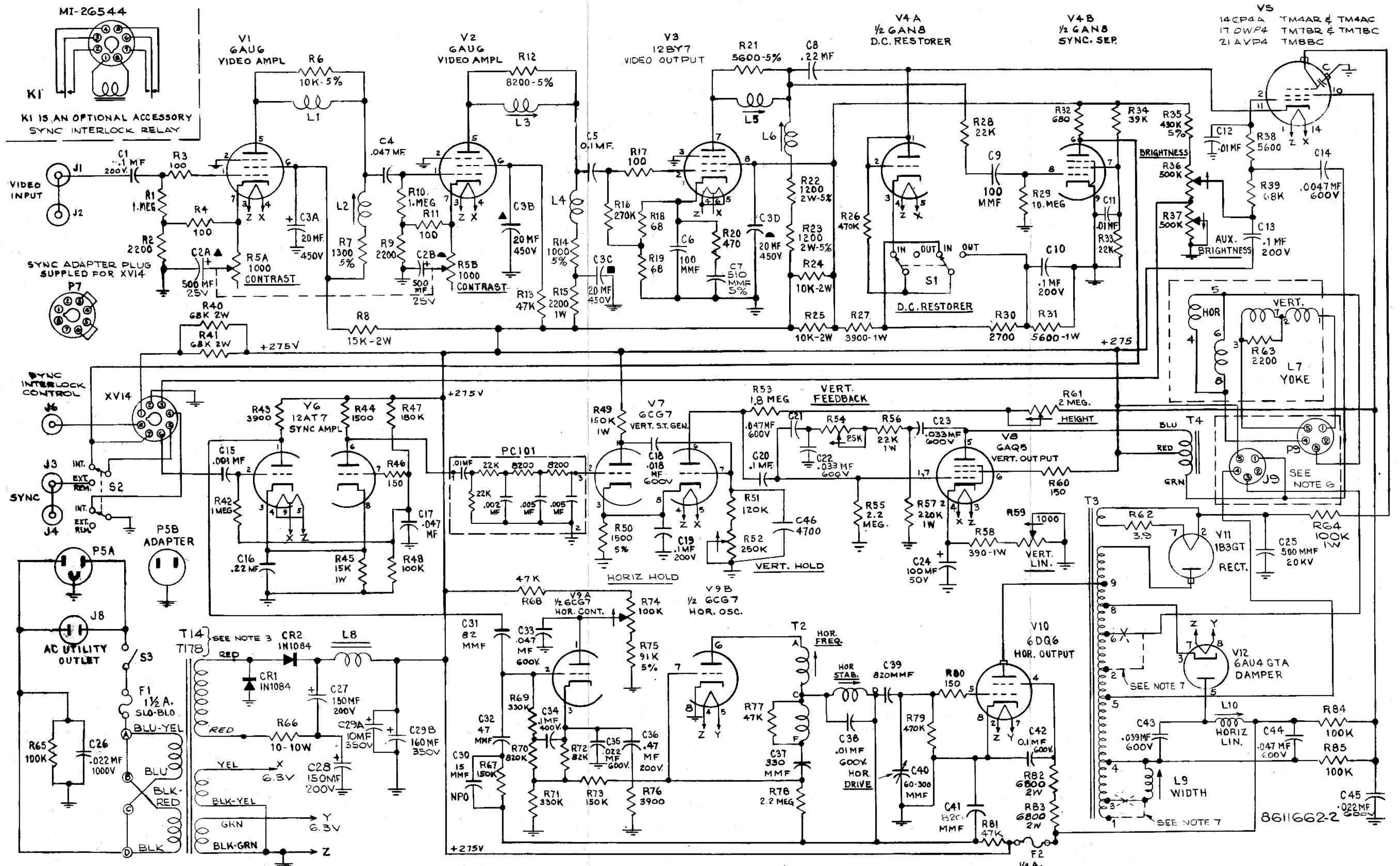
Figure PM-8. Picture Monitor (Bottom View)

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			CAPACITORS:
C1			paper, 0.1 μf ±20%, 200 v
C2A/B	216271		electrolytic, 500/500 μf, 25 v
C3A/D	98408		electrolytic, 20/20/20/20 μf, 450 v
C4			paper, 0.047 μf ±20%, 400 v
C5			paper, 0.1 μf ±20%, 400 v
C6	98422		mica, 100 $\mu\mu$f ±10%, 300 v
C7	218966		mica, 510 $\mu\mu$f ±5%, 300 v
C8			paper, 0.22 μf ±20%, 400 v
C9	98422		mica, 100 $\mu\mu$f ±20%, 300 v
C10			paper, 0.1 μf ±20%, 200 v
C11, C12	73960		ceramic, 0.01 μf +100 -0%, 500 v
C13			paper, 0.1 μf ±20%, 200 v
C14			paper, 0.0047 μf ±20%, 600 v
C15	102234A		ceramic, 0.001 μf ±20%, 500 v
C16			paper, 0.22 μf ±20%, 400 v
C17			paper, 0.047 μf ±20%, 400 v
C18			paper, 0.018 μf ±10%, 600 v
C19			paper, 0.1 μf ±20%, 200 v
C20			paper, 0.1 μf ±10%, 400 v
C21			paper, 0.047 μf ±10%, 600 v
C22, C23			paper, 0.033 μf ±10%, 600 v
C24	214667		electrolytic, 100 μf, 50 v
C25	99126		mica, 500 μf, 20 KV
C26			paper, 0.022 μf ±20%, 1000 v
C27, C28	75220		electrolytic, 150 $\mu\mu$f, 200 v
C29A/B	219150		electrolytic, 160-10 μf, 350 v
C30	109316		ceramic, 15 $\mu\mu$f N.P.O. ±5%, 500 v
C31	218221		mica, 82 $\mu\mu$f ±10%, 300 v
C32	95320		mica, 47 $\mu\mu$f ±10%, 300 v
C33			paper, 0.047 μf ±20%, 600 v
C34			paper, 0.1 μf ±20%, 400 v
C35			paper, 0.022 μf ±20%, 600 v
C36			paper, 0.47 μf ±20%, 200 v
C37	79191		mica, 330 $\mu\mu$f ±20%, 300 v
C38			paper, 0.01 μf ±20%, 600 v
C39	78143		mica, 820 $\mu\mu$f ±10%, 300 v
C40	94771		variable, ceramic, 60-300 $\mu\mu$f
C41	78143		mica, 820 $\mu\mu$f ±10%, 300 v
C42			paper, 0.1 μf ±20%, 600 v
C43			paper, 0.039 μf ±10%, 600 v
C44			paper, 0.047 μf ±20%, 600 v
C45			paper, 0.022 μf ±20%, 600 v
C46			ceramic, 0.0047 μf ±20%
CR1, CR2	217351		Rectifier: silicon diode
F1	98682		Fuse: 1-1/2 amp, slo-blo
F2	218140		Fuse: 1/4 amp, slo-blo
J1 to J4	51800		Connector: female, single contact
J5			Not Used
J6	35787		Connector: phono jack
J7			Not Used
J8	52855		Connector: female, 2 contact
J9	35787		Socket: yoke
L1	219153		Coil: video peaking
L2	219154		Coil: video peaking
L3	219155		Coil: video peaking
L4	216450		Coil: video peaking
L5	219156		Coil: video peaking
L6	219157		Coil: video peaking
L7	219158		Yoke: deflection
L8	213319		Reactor: filter choke
L9	219159		Coil: width
L10	219160		Coil: horizontal linearity
P1 to P4			Not Used
P5A	219162		Cable: power and connector

Symbol No.	Stock No.	Drawing No.	Description
P5B	215349		Connector: power cable adaptor
P6	31048		Connector: phono plug
P7	51209		Connector: adapter for XV14 (Sync relay)
P8			Not Used
P9			Connector: yoke plug
PC101	79246		Intergrator: vert.
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1			1 meg ±10%, ½ w
R2			2200 ohm ±10%, ½ w
R3, R4			100 ohm ±10%, ½ w
R5A/B	219165		variable comp., 1000/1000 ohm ±20%, 2 w
R6			10,000 ohm ±5%, ½ w
R7			1300 ohm ±5%, ½ w
R8			15,000 ohm ±10%, 2 w
R9			2200 ohm ±10%, ½ w
R10			1 meg ±10%, ½ w
R11			100 ohm ±10%, ½ w
R12			8200 ohm ±5%, ½ w
R13			47,000 ohm ±10%, ½ w
R14			1000 ohm ±5%, ½ w
R15			2200 ohm ±10%, 1 w
R16			270,000 ohm ±10%, ½ w
R17			100 ohm ± %, ½ w
R18, R19			68 ohm ±10%, ½ w
R20			470 ohm +10%, ½ w
R21			5600 ohm ±5%, ½ w
R22, R23			1200 ohm ±5%, 2 w
R24, R25			10,000 ohm ±10%, 2 w
R26			470,000 ohm ±10%, ½ w
R27			3900 ohm ±10%, 1 w
R28			22,000 ohm ±10%, 1 w
R29			10 meg ±10%, 1 w
R30			2700 ohm ±10%, ½ w
R31			5600 ohm ±10%, 1 w
R32			680 ohm ±10%, ½ w
R33			22,000 ohm ±10%, 1 w
R34			39,000 ohm ±10%, ½ w
R35			430,000 ohm ±5%, ½ w
R36	213322		varaible, comp., 500,000 ohm ±30%, ½ w
R37	213322		variable, comp., 500,000 ohm ±30%, ½ w
R38			5600 ohm ±10%, ½ w
R39			68,000 ohm ±10%, ½ w
R40, R41			68,000 ohm ±10%, 2 w
R42			1 meg ±10%, ½ w
R43			3900 ohm ±10%, ½ w
R44			1500 ohm ±10%, ½ w
R45			15,000 ohm ±10%, 1 w
R46			150 ohm ±10%, ½ w
R47			180,000 ohm ±10%, ½ w
R48			100,000 ohm ±10%, ½ w
R49			150,000 ohm ±10%, 1 w
R50			1500 ohm ±5%, ½ w
R51			120,000 ohm ±10%, ½ w
R52	213323		variable, comp., 250,000 ohm ±20%, 2 w
R53			1.8 meg ±10%, ½ w
R54	219151		variable, comp., 25,000 ohm ±20%, ½ w
R55			2.2 meg ±10%, ½ w
R56			22,000 ohm ±10%, 1 w
R57			220,000 ohm ±10%, 1 w
R58			390 ohm ±10%, 1 w
R59	219166		variable, wire wound, 1000 ohm ±20%, 2 w
R60			150 ohm ±10%, ½ w
R61	213324		variable, comp., 2 meg ±30%, 2 w

Symbol No.	Stock No.	Drawing No.	Description
R62	103030		wire wound, 3.9 ohm ±10%, ½ w
R63			2200 ohm ±10%, ½ w
R64			100,000 ohm ±10%, 1 w
R65			100,000 ohm ±10%, ½ w
R66	216957		wire wound, 10 ohm, 10 w
R67			150,000 ohm ±10%, ½ w
R68			47,000 ohm ±10%, ½ w
R69			330,000 ohm ±10%, ½ w
R70			820,000 ohm ±10%, ½ w
R71			330,000 ohm ±10%, ½ w
R72			82,000 ohm ±10%, ½ w
R73			150,000 ohm ±10%, ½ w
R74	213327		variable, comp., 100,000 ohm ±20%, 2 w
R75			91,000 ohm ±5%, ½ w
R76			3900 ohm ±10%, ½ w
R77			47,000 ohm ±10%, ½ w
R78			2.2 meg ±10%, ½ w
R79			470,000 ohm ±10%, ½ w
R80			150 ohm ±10%, ½ w
R81			47,000 ohm ±10%, ½ w
R82, R83			6800 ohm ±10%, 2 w
R84, R85			100,000 ohm ±10%, ½ w
S1, S2	96714		Switch: slide, D.P.D.T.
S3	97715		Switch: toggle, S.P.S.T.
T1			Not Used
T2	216960		Transformer: synchro guide
T3	221312		Transformer: hi-voltage
T4	213329		Transformer: vertical output
T5 to T177			Not Used
T178	219167		Transformer: power
XCR1, XCR2			Holder: silicon diode
XF1, XF2	48894		Holder: fuse
XV1, XV2	94925		Socket: tube, 7 pin
XV3, XV4	94926		Socket: tube, 9 pin
XV5	74834		Socket: kine, 5-20″ leads
XV6, XV7	94926		Socket: tube, 9 pin
XV8	94925		Socket: tube, 7 pin
XV9	94926		Socket: tube, 9 pin
XV10	68590		Socket: tube, octal
XV11	216961		Socket: tube (1B3)
XV12	68590		Socket: tube·octal
			Miscellaneous:
	219163		Cap: plate for V1C
	219161		Cap: tube, cap for C25
	213589		Glass: safety 17″
	219164		Insulator: 1B3 socket
	76141		Ion Trap
	57711		Knob: black control
	79964		Lead: H.V. anode
	219168		Magnet: focus and centering
	213517		Mask: 17″ for kine



NOTES

1. FOR 115V STRAP Ⓐ TO Ⓑ & Ⓒ TO Ⓓ
2. FOR 230V REMOVE STRAP FROM Ⓐ TO Ⓑ & Ⓒ TO Ⓓ & STRAP Ⓑ TO Ⓒ.
3. T14 IS USED ON TM4AR & TM4AC ONLY.

T178 IS USED ON TM7BC, TM7BR & TM8BC ONLY

4. ALL RESISTOR VALUES IN OHMS, ½W, 10% UNLESS OTHERWISE SPECIFIED.
5. ALL CAPACITOR VALUES ARE 400V, 10% UNLESS OTHERWISE SPECIFIED.
6. P9 & J9 ARE USED IN THE TM7BR, TM7BC & TM8BC ONLY.
7. TO UNDER SCAN CONNECT LEAD ON T3-6 TO T3-2 & THE LEAD ON T3-3 TO T3-1.

Figure PM-9. Schematic Diagram

Video Record Amplifier

UNIT 104

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
PP 651

IB-31134

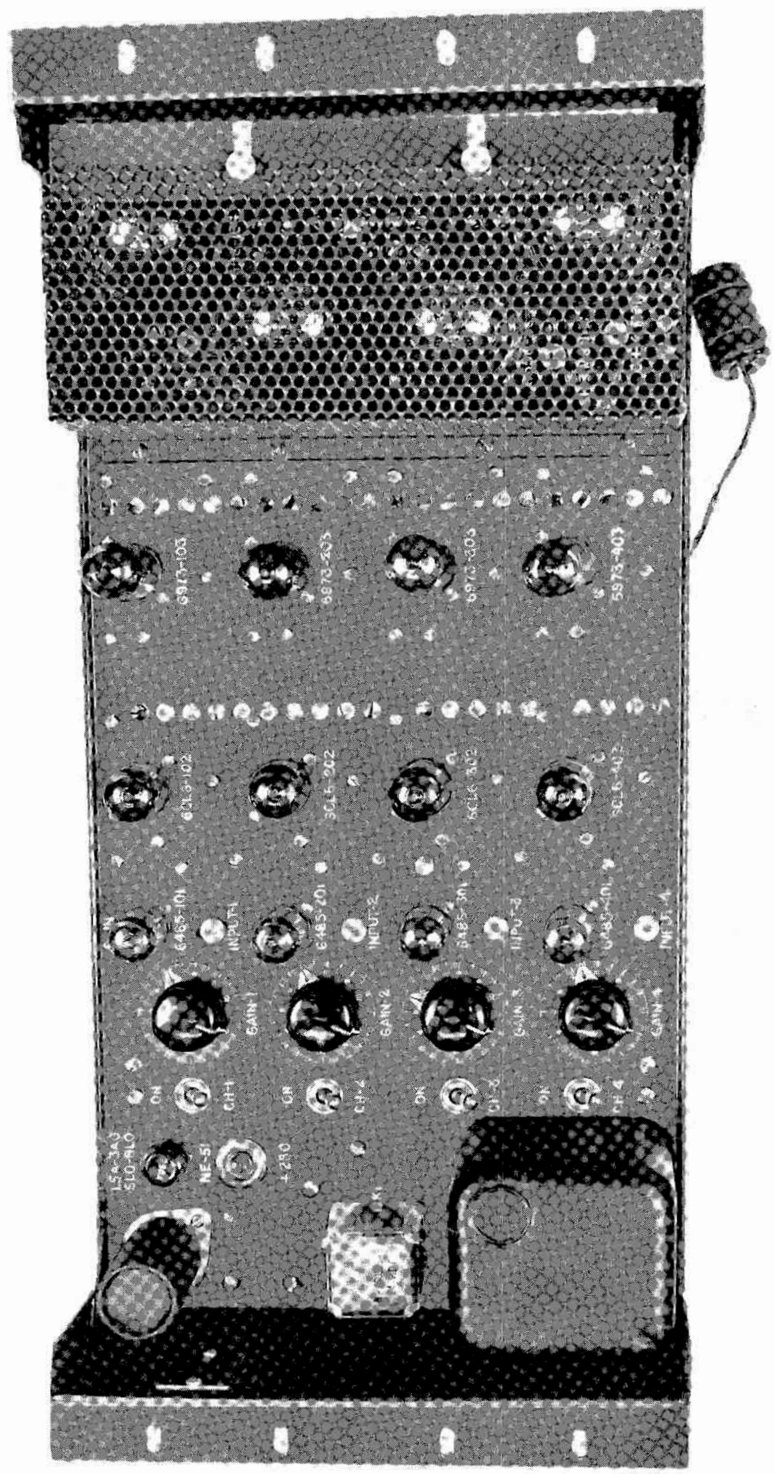


Figure VRA-1. Video Record Amplifier

TECHNICAL DATA

Power Required

Filament Transformer: 117 volts, 50/60 cps, 90 watts (from circuit breaker No. 1)

Plate: 280 volts dc, 940 ma (from power supply No. 1, unit 409)

Number of Amplifier Channels

Four (one for each video head in headwheel)

Input Impedance (each channel)

75 ohms

Input

Four FM signals from Record Delay Amplifier

Output Load

Four Video Heads

Maximum FM Output Current

200 ma peak-to-peak

Frequency Response

Flat from 0.5 mc to 7 mc ± 1 db

Fuses

1 SLO-BLO 3AG, ½ amp
4 fast acting, 8AG, ⅛ amp

DESCRIPTION

The Video Record Amplifier (figure VRA-1) which provides final amplification of the f-m signals, contains four identical amplifier channels. These channels amplify the f-m outputs of the record delay amplifier, to supply the driving currents to the four video heads. A gain control in each channel is used to optimize the current for each of the four video heads.

In addition, the record amplifier contains a transfer relay which applies B+ voltage to the different f-m chassis in accordance with the mode of operation. To permit monitoring the individual head currents, a rectifier circuit in each channel feeds a d-c voltage, proportional to the head current, to the circuit of the RECORD CURRENT meter on the control panel.

The driver stages are shielded on the front and rear of the chassis to prevent cross coupling with other tape recorders. A fan mounted on the rear of the chassis cools the output stages; also, special low-capacitance cables (between the output jacks and the video preamplifier, unit 203) are used to reduce attenuation of high frequencies.

Circuit

The four separate signals from the record delay amplifier enter the unit through jacks J101, J201, J301, and J401 (see figures VRA-5 and 6). The first stage in each channel has a gain control which is adjustable from the front panel. Amplification in each channel is achieved by three voltage amplifiers whose output circuits use shunt or series peaking, or a combination of both types.

The outputs of the record amplifier are used to drive the video heads which are also the ac loads for the output amplifiers. However note, before the signals reach the output jacks of their respective channels, they pass through a 125 ma fuse (e.g. F101, Chan. 1) which is used to protect the head from excessive currents in case of component failure.

A toggle switch in each channel is also provided as a safety measure to avoid damage of the video heads. For instance, if troubleshooting becomes necessary on the headwheel servo system, there may be times when the machine is in the RECORD or SETUP mode, and the headwheel motor is standing still. As a precaution against excessive heating and possible damage to the video heads, the switch is provided in the output of each channel so that B+ may be cut off from the driver stage.

A peak-to-peak detector (CR101, CR102, etc.) samples a portion of the cathode voltage of each stage. Since the cathode voltage is proportional to the head current, the sampled voltage is an indication of the head current. The detected voltage for each channel is monitored on the RECORD CURRENT meter, located on the control panel, by selecting the desired channel on the VIDEO METER SEL switch.

Transfer relay K1 (controlled from the control panel) is the main B+ relay that energizes the proper FM chassis during the RECORD mode, and at the same time it de-energizes the fm chassis used during playback. In the PLAYBACK mode, relay K1 de-energizes the fm chassis used for recording and energizes the fm chassis used during playback. For example, in RECORD and SETUP, relay K1 is energized and supplies B+ to the record amplifier, record delay amplifier, and the erase oscillator unit. In PLAYBACK, STANDBY and WIND modes, the relay is de-energized and supplies B+ power to the preamplifier, playback amplifier, playback delay amplifier, equalizer, and the 4X2 switcher (see figure VRA-7). Two neon bulbs give indication of B+ voltage on each chassis.

OPERATION

Operating the record amplifier consists of setting the four gain controls R101, R201, R301, and R401, for optimum head currents. This procedure entitled *Head Optimization* is outlined in the instruction for the headwheel panel, and also in the *Operation Manual*.

MAINTENANCE

-Waveforms shown in figure VRA-3 are provided to assist in troubleshooting. The information beneath each waveform gives the levels at various points throughout the unit; these levels will vary depending on the current required for head optimization.

The table of *Typical Tube Socket Voltages* (page 13) should be referred to when troubleshooting the unit. Make certain to refer to the notes given below the table.

The following procedure should be used when sweeping any of the four channels. Refer to figure VRA-2 for proper waveforms.

1. Disconnect the cable from the input jack of the channel to be swept.

2. Connect a video sweep generator (1 to 10 mc) to the input jack.

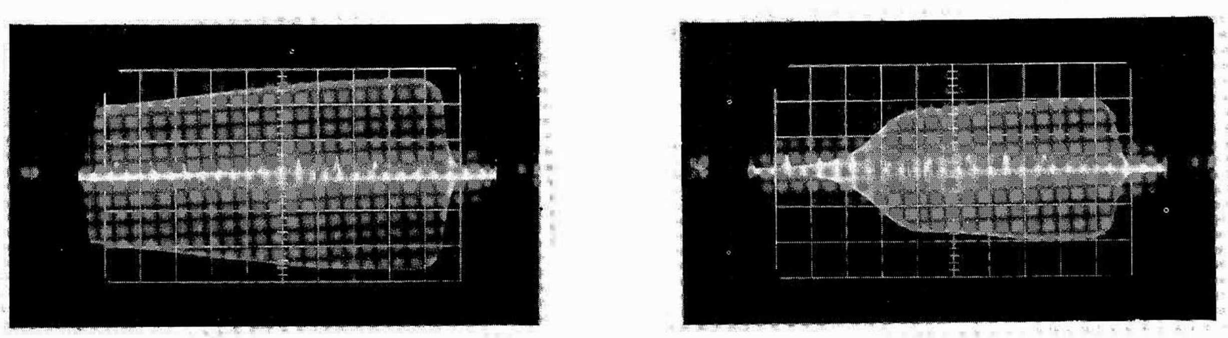
3. Turn OFF output stage B+ switch to other three channels.

4. Place machine in SET-UP.

5. Connect a Tektronix Type 535 scope (or equivalent) to TP1 on the video preamplifier chassis. The output should be as shown in figure VRA-2B when compared to input figure VRA-2A.

NOTES:

1. Photographs taken from a Tektronix Type 535 scope, 10:1 attenuator, 11.5 $\mu\mu$f probe.
2. Turn off B+ switches to all channels except the one being checked.
3. Sweep frequency runs right to left. Each marker indicates 1 mc, starting at 3 mc on the right and going to 11 mc on the left.



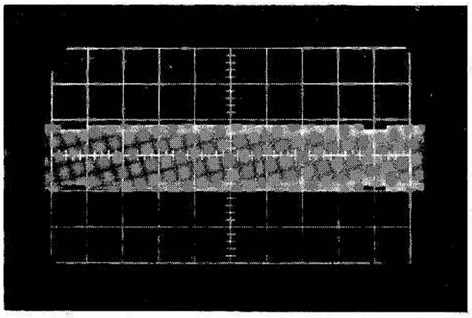
A. FM Input J101 (TP101) (.05v/Div)

B. Record Amp Output across 10 Ω Res., TP1 on Preamplifier Chassis (Unit 203) (.2v/Div)

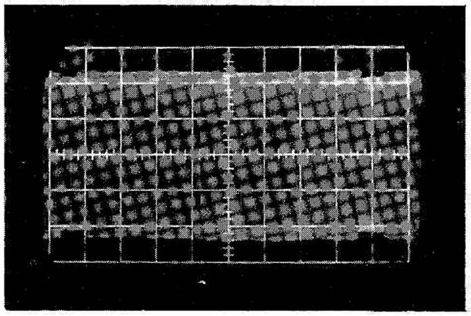
Figure VRA-2. Video Record Amplifier, Input and Output Sweep Response

NOTES:

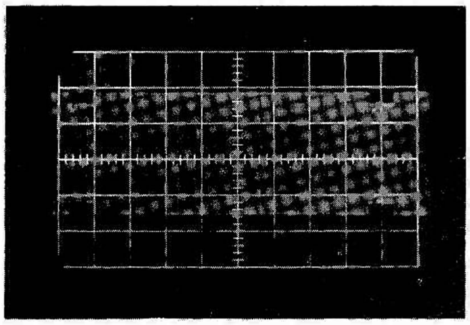
1. All photographs have the same time base, 2 milliseconds/cm.
2. Data taken with machine in SETUP mode.
3. Waveform taken of channel 1; also typical for other channels.
4. Waveforms taken with Tektronix Type 535A; 10:1 attenuator, 11.5 $\mu\mu$f probe.
5. Remove probe before recording.



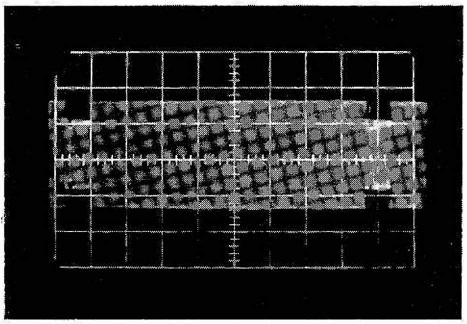
A. TP101 (.2v/cm)



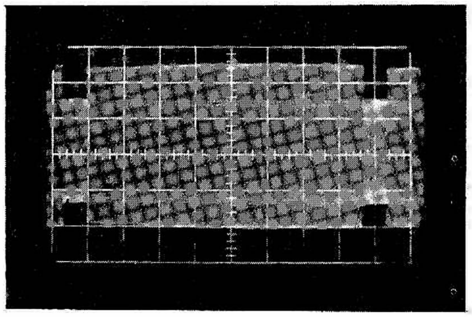
B. V101 Pin 5 (.2v/cm)



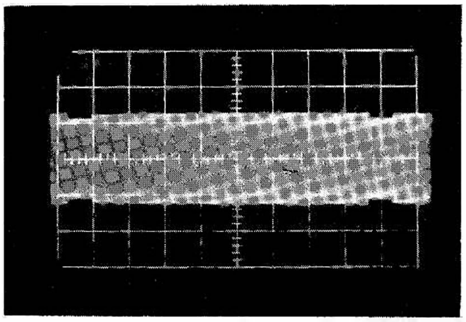
C. V102 Pin 6 (2v/cm)



D. V103 Pin 9 (20v/cm)



E. TP102 (2v/cm)



F. TP1 on Preamplifier (Unit 203) All Heads Off Except CH-1 (.5v/cm)

Figure VRA-3. Video Record Amplifier, Waveforms and Voltage Levels

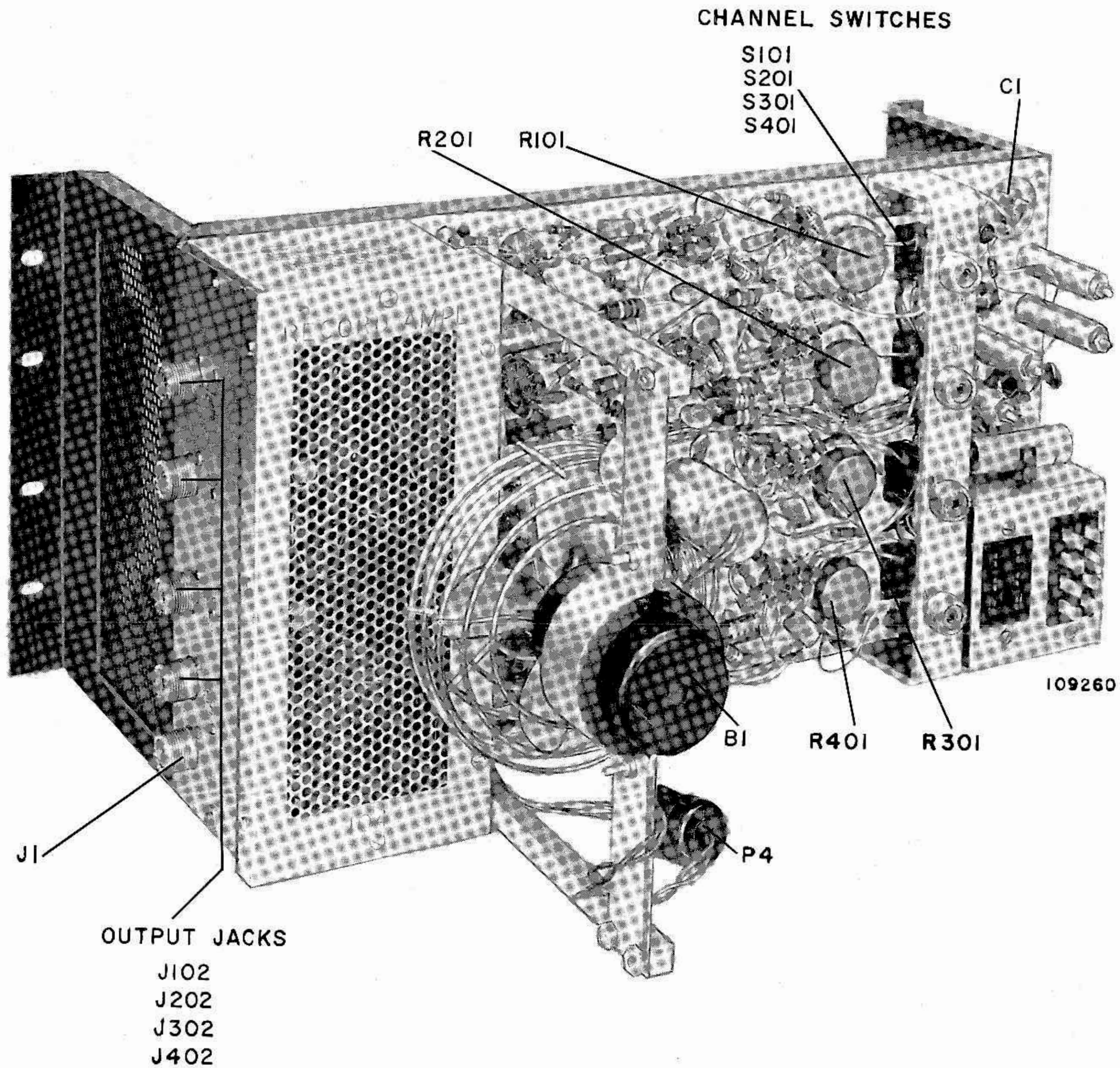


Figure VRA-4. Video Record Amplifier, Rear View

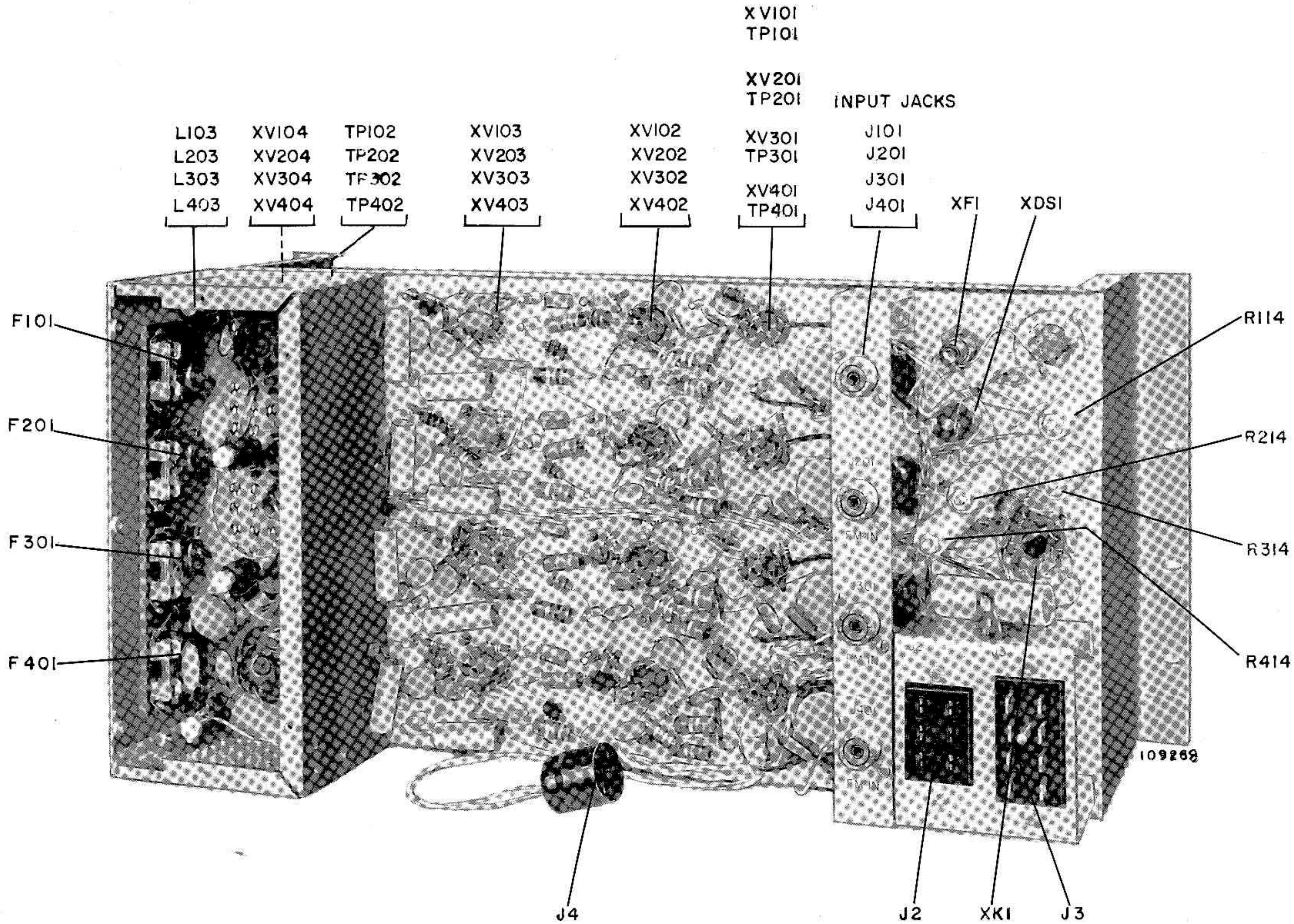


Figure VRA-5. Video Record Amplifier, Blower and Shield Removed

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
RECORD AMPLIFIER (8971481-501)			9
B1	97264A	486670-1	Blower: 115 v, 50/60 cycle
			CAPACITORS:
C1A/B	99295	458557-5	electrolytic, 20/20 μf, 450 v
C2, C3		735715-179	paper, 0.22 μf ±10%, 400 v
C4 to C7		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C8 to C100			Not Used
C101		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C102			Not Used
C103		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C104		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C105, C106		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C107		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C108 to C110		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C111		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C112 to C115		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C116		8411456-23	ceramic, 10,000 μμf ±10%, 1000 v
C117		727851-111	mica, 33 μμf ±10%, 500 v char "B"
C118	101610	936282-4	ceramic, 0.1 μf +100 -20%, 30 v
C119 to C200			Not Used
C201		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C202			Not Used
C203		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C204		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C205, C206		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C208 to C210		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C210		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C211		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C212 to C215		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C216		8411456-23	ceramic, 10,000 μμf ±10%, 1000 v
C217		727851-111	mica, 33 μμf ±10%, 500 v char "B"
C218	101610	936282-4	ceramic, 0.1 μf +100 -20%, 30 v
C219 to C300			Not Used
C301		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C302			Not Used
C303		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C304		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C305, C306		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C307		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C308 to C310		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C311		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C312 to C315		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C316		8411456-23	ceramic, 10,000 μμf ±10%, 1000 v
C317		727851-111	mica, 33 μμf ±10%, 500 v char "B"
C318	101610	936282-4	ceramic, 0.1 μf +100 -20%, 30 v
C319 to C400			Not Used
C401		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C402			Not Used
C403		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C404		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C405, C406		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C407		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C408 to C410		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C411		727851-139	mica, 470 μμf ±10%, 300 v char "B"
C412 to C415		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
C416		8411456-23	ceramic, 10,000 μμf ±10%, 1000 v
C417		727851-111	mica, 33 μμf ±10%, 500 v char "B"
C418	101610	936282-4	Ceramic, 0.1 μf +100 -20%, 30 v
CR101, CR102	59395		Diode: type 1N34A
CR103 to CR200			Not Used
CR201, CR202	59395		Diode: type 1N34A
CR203 to CR300			Not Used
CR301, CR302	59395		Diode: type 1N34A
CR303 to CR400			Not Used

Symbol No.	Stock No.	Drawing No.	Description
CR401, CR402	59395		Diode: type 1N34A
DS1	101857	872291-9	Lamp: indicator
F1	98682	990157-109	Fuse: 1.5 amp, 125 v, slo-blo
F2 to F100			Not Used
F101	218479	8851771-24	Fuse: 1/8 amp, 250 v
F102 to F200			Not Used
F201	218479	8851771-24	Fuse: 1/8 amp, 250 v
F202 to F300			Not Used
F301	218479	8851771-24	Fuse: 1/8 amp, 250 v
F302 to F400			Not Used
F401	218479	8851771-24	Fuse: 1/8 amp, 250 v
J1	51800	255223-2	Connector: coax, chassis mtg.
J2	51594	727969-1	Connector: female, 6 contact, chassis mtg.
J3	55806	727969-7	Connector: male, 8 contact, chassis mtg.
J4	4573	67089-4	Connector: female, 2 contact, cable mtg.
J5 to J100			Not Used
J101, J102	51800	255223-2	Connector: coax, chassis mtg.
J103 to J200			Not Used
J201, J202	51800	255223-2	Connector: coax, chassis mtg.
J203 to J300			Not Used
J301, J302	51800	255223-2	Connector: coax, chassis mtg.
J303 to J400			Not Used
J401, J402	51800	255223-2	Connector: coax, chassis mtg.
K1	221673	460355-10	Relay: 24 v D.C., SPDT
L1		8973730-1	Coil: 10 turns of 0.0320 dia. wire
L2 to L100			Not Used
L101	202910	8825473-505	Coil: choke, 10 microhenry
L102	203437	8825473-514	Coil: choke, 60 microhenry
L103	218480	8835360-2	Coil: choke, 1 mh
L104	204681	8825473-508	Coil: choke, 25 microhenry
L105	214924	8825473-512	Coil: choke, 45 microhenry
L106 to L200			Not Used
L201	202910	8825473-505	Coil: choke, 10 microhenry
L202	203437	8825473-514	Coil: choke, 60 microhenry
L203	218480	8835360-2	Coil: choke, 1 mh
L204	204681	8825473-508	Coil: choke, 25 microhenry
L205	214924	8825473-512	Coil: choke, 45 microhenry
L206 to L300			Not Used
L301	202910	8825473-505	Coil: choke, 10 microhenry
L302	203437	8825473-514	Coil: choke, 60 microhenry
L303	218480	8835360-2	Coil: choke, 1 mh
L304	204681	8825473-508	Coil: choke, 25 microhenry
L305	214924	8825473-512	Coil: choke, 45 microhenry
L306 to L400			Not Used
L401	202910	8825473-505	Coil: choke, 10 microhenry
L402	203437	8825473-514	Coil: choke, 60 microhenry
L403	218480	8835360-2	Coil: choke, 1 mh
L404	204681	8825473-508	Coil: choke, 25 microhenry
L405	214924	8825473-512	Coil: choke, 45 microhenry
P1			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adapter: solder type
P2	51595	727969-2	Connector: male, 6 contact, cable mtg.
P3	55808	727969-8	Connector: female, 8 contact, cable mtg.
P4	4577	67089-3	Connector: blower leads
P5 to P100			Not Used
P101			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P102			See Cable Assembly under Miscellaneous
P103 to P200			Not Used
P201			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8970036-3	Sleeve only

Symbol No.	Stock No.	Drawing No.	Description
P202			See Cable Assembly under Miscellaneous
P203 to P300			Not Used
P301			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P302			See Cable Assembly under Miscellaneous
P303 to P400			Not Used
P401			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve
P402			See Cable Assembly under Miscellaneous
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-94	470,000 ohm ±10%, ½ w
R2			Part of XDS1
R3 to R100			Not Used
R101	95244	8971860-2	variable, comp., 100 ohm ±10%, 2 w
R102		82283-90	220,000 ohm ±10%, ½ w
R103		82283-139	150 ohm ±5%, ½ w
R104		82283-157	820 ohm ±5%, ½ w
R105, R106		99126-79	27,000 ohm ±10%, 2 w
R107		82283-54	220 ohm ±10%, ½ w
R108		82283-86	100,000 ohm ±10%, ½ w
R109		82283-141	180 ohm ±5%, ½ w
R110		99126-165	1800 ohm ±5%, 2 w
R111		99126-66	2200 ohm ±10%, 2 w
R112		90496-80	33,000 ohm ±10%, 1 w
R113		82283-78	22,000 ohm ±10%, ½ w
R114	74049	140294-39	wire wound, 500 ohm ±5%, 20 w
R115		82283-86	100,000 ohm ±10%, ½ w
R116		82283-54	220 ohm ±10%, ½ w
R117		82283-139	150 ohm ±5%, ½ w
R118, R119	54418	8817659-9	wire wound, 1200 ohm ±5%, 5 w
R120		90496-76	15,000 ohm ±10%, 1 w
R121		82283-76	15,000 ohm ±10%, ½ w
R122		82283-54	220 ohm ±10%, ½ w
R123		82283-86	100,000 ohm ±10%, ½ w
R124	218481	990736-159	Film, 40.2 ohm ±1%, 2 w
R125		99126-127	47 ohm ±5%, 2 w
R126		90496-38	10 ohm ±10%, 1 w
R127		90496-62	1000 ohm ±10%, 1 w
R128		99126-66	2200 ohm ±10%, 2 w
R129		82283-86	100,000 ohm ±10%, ½ w
R130		82283-62	1000 ohm ±10%, ½ w
R131		82283-145	270 ohm ±5%, ½ w
R132 to R200			Not Used
R201	95244	8971860-2	variable, comp, 100 ohm ±10%, 2 w
R202		82283-90	220,000 ohm ±10%, ½ w
R203		82283-139	150 ohm ±5%, ½ w
R204		82283-157	820 ohm ±5%, ½ w
R205, R206		99126-79	27,000 ohm ±10%, 2 w
R207		82283-54	220 ohm ±10%, ½ w
R208		82283-86	100,000 ohm ±10%, ½ w
R209		82283-141	180 ohm ±5%, ½ w
R210		99126-165	1800 ohm ±5%, 2 w
R211		99126-66	2200 ohm ±10%, 2 w
R212		90496-80	33,000 ohm ±10%, 1 w
R213		82283-78	22,000 ohm ±10%, ½ w
R214	74049	140294-39	wire wound, 500 ohm ±5%, 20 w
R215		82283-86	100,000 ohm ±10%, ½ w
R216		82283-54	220 ohm ±10%, ½ w
R217		82283-139	150 ohm ±5%, ½ w

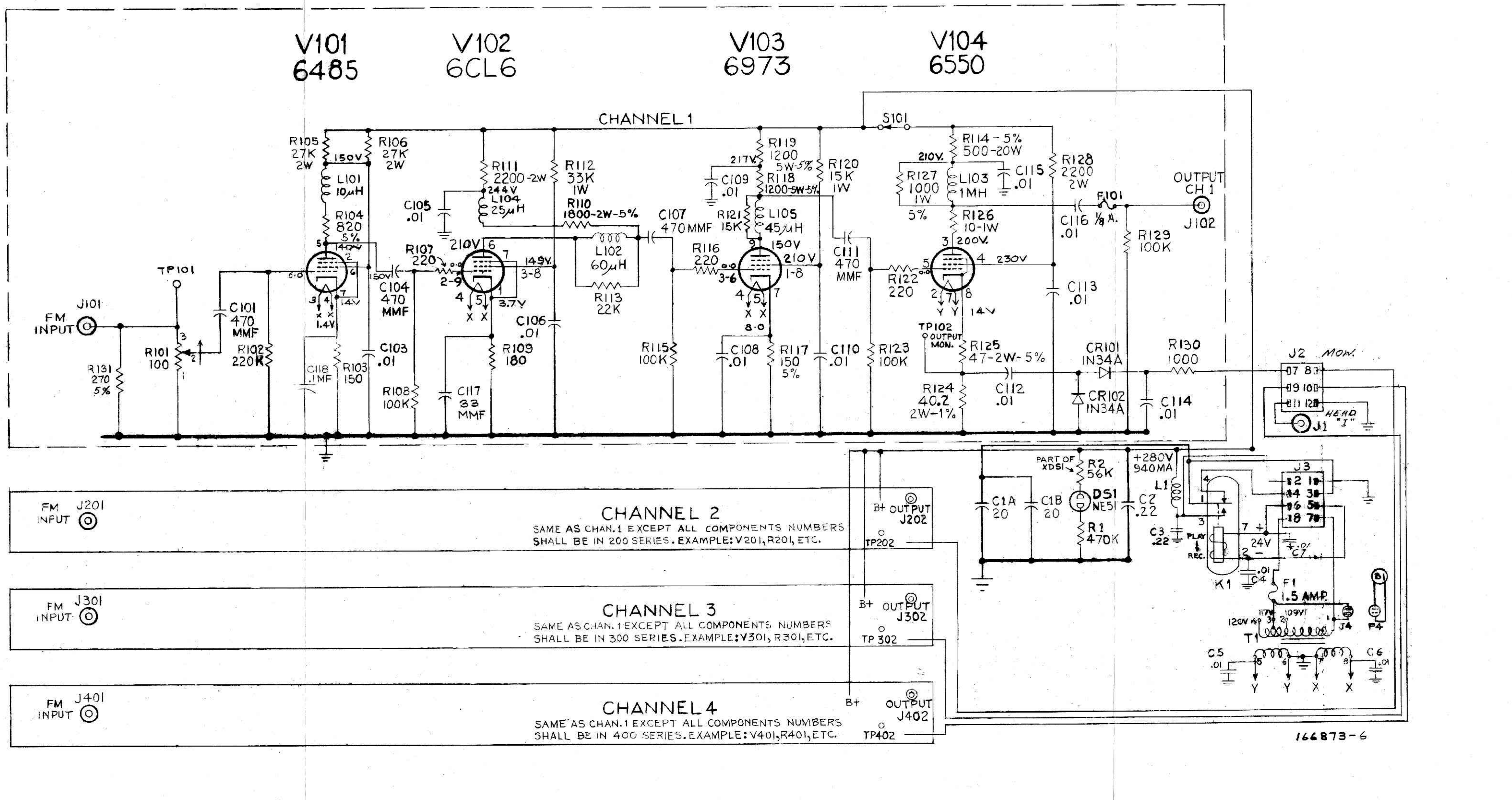
Symbol No.	Stock No.	Drawing No.	Description
R218,R219	54418	8817659-9	wire wound, 1200 ohm ±5%, 5 w
R220		90496-76	15,000 ohm ±10%, 1 w
R221		82283-76	15,000 ohm ±10%, ½ w
R222		82283-54	220 ohm ±10%, ½ w
R223		82283-86	100,000 ohm ±10%, ½ w
R224	218481	990736-159	Film, 40.2 ohm ±1%, 2 w
R225		99126-127	47 ohm ±5%, 2 w
R226		90496-38	10 ohm ±10%, 1 w
R227		90496-62	1000 ohm ±10%, 1 w
R228		99126-66	2200 ohm ±10%, 2 w
R229		82283-86	100,000 ohm ±10%, ½ w
R230		82283-62	1000 ohm ±10%, 1 w
R231		82283-145	270 ohm, ±5%, ½ w
R232 to R300			Not Used
R301	95244	8971860-2	variable, comp., 100 ohm ±10%, 2 w
R302		82283-90	220,000 ohm ±10%, ½ w
R303		82283-139	150 ohm ±5%, ½ w
R304		82283-157	820 ohm ±5%, ½ w
R305,R306		99126-79	27,000 ohm ±10%, 2 w
R307		82283-54	220 ohm ±10%, ½ w
R308		82283-86	100,000 ohm ±10%, ½ w
R309		82283-141	180 ohm ±5%, ½ w
R310		99126-165	1800 ohm ±5%, 2 w
R311		99126-66	2200 ohm ±10%, 2 w
R312		90496-80	33,000 ohm ±10%, 1 w
R313		82283-78	22,000 ohm ±10%, ½ w
R314	74049	140294-39	wire wound, 500 ohm ±5%, 20 w
R315		82283-86	100,000 ohm ±10%, ½ w
R316		82283-54	220 ohm ±10%, ½ w
R317		82283-139	150 ohm ±5%, ½ w
R318,R319	54418	8817659-9	wire wound, 1200 ohm ±5%, 5 w
R320		90496-76	15,000 ohm ±10%, 1 w
R321		82283-76	15,000 ohm ±10%, ½ w
R322		82283-54	220 ohm ±10%, ½ w
R323		82283-86	100,000 ohm ±10%, ½ w
R324	218481	990736-159	film, 40.2 ohm ±1%, 2 w
R325		99126-127	47 ohm ±5%, 2 w
R326		90496-38	10 ohm ±10%, 1 w
R327		90496-62	1000 ohm ±10%, 1 w
R328		99126-66	2200 ohm ±10%, 2 w
R329		82283-86	100,000 ohm ±10%, ½ w
R330		82283-62	1000 ohm ±10%, 1 w
R331		82283-145	270 ohm ±5%, ½ w
R332 to R400			Not Used
R401	95244	8971860-2	variable, comp., 100 ohm ±10%, 2 w
R402		82283-90	220,000 ohm ±10%, ½ w
R403		82283-139	150 ohm ±5%, ½ w
R404		82283-157	820 ohm ±5%, ½ w
R405,R406		99126-79	27,000 ohm ±10%, 2 w
R407		82283-54	220 ohm ±10%, ½ w
R408		82283-86	100,000 ohm ±10%, ½ w
R409		82283-141	180 ohm ±5%, ½ w
R410		99126-165	1800 ohm ±5%, 2 w
R411		99126-66	2200 ohm ±10%, 2 w
R412		90496-80	33,000 ohm ±10%, 1 w
R413		82283-78	22,000 ohm ±10%, ½ w
R414	74049	140294-39	wire wound, 500 ohm ±5%, 20 w
R415		82283-86	100,000 ohm ±10%, ½ w
R416		82283-54	220 ohm ±10%, ½ w
R417		82283-139	150 ohm ±5%, ½ w
R418,R419	54418	8817659-9	wire wound, 1200 ohm ±5%, 5 w
R420		90496-76	15,000 ohm ±10%, 1 w
R421		82283-76	15,000 ohm ±10%, ½ w
R422		82283-54	220 ohm ±10%, ½ w
R423		82283-86	100,000 ohm ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R424	218481	990736-159	film, 40.2 ohm ±1%, 2 w
R425		99126-127	47 ohm ±5%, 2 w
R426		90496-38	10 ohm ±10%, 1 w
R427		90496-62	1000 ohm ±10%, 1 w
R428		99126-66	2200 ohm ±10%, 2 w
R429		82283-86	100,000 ohm ±10%, ½ w
R430		82283-62	1000 ohm ±10%, 1 w
R431		82283-145	270 ohm, ±5%, ½ w
S101	48791	187454-1	Switch: toggle, SPST
S102 to S200			Not Used
S201	48791	187454-1	Switch: toggle, SPST
S202 to S300			Not Used
S301	48791	187454-1	Switch: toggle, SPST
S302 to S400			Not Used
S401	48791	187454-1	Switch: toggle, SPST
T1	218478	8437856-1	Transformer: filament
TP101, TP102	208983	8825493-7	Jack: tip, yellow
TP103 to TP200			Not Used
TP201, TP202	208983	8825493-7	Jack: tip, yellow
TP203 to TP300			Not Used
TP301, TP302	208983	8825493-7	Jack: tip, yellow
TP303 to TP400			Not Used
TP401, TP402	208983	8825493-7	Jack: tip, yellow
V101, V201, V301, V401	209149		Tube: type 6485
V104, V204, V304, V404	210752		Tube: type 6550
XADS1	208080	990788-507	Lens: indicator light
XDS1	208458	990789-5	Socket: lamp
XF1	48894	99088-2	Socket: fuse
XK1	68590	99100-4	Socket: relay
XV101	94925	737867-14	Socket: tube, 7 pin
XV102, XV103	94926	737870-14	Socket: tube, 9 pin
XV104	68590	99100-4	Socket: tube, 8 pin
XV105 to XV200			Not Used
XV201	94925	737867-14	Socket: tube, 7 pin
XV202, XV203	94926	737870-14	Socket: tube, 9 pin
XV204	68590	99100-4	Socket: tube, 8 pin
XV205 to XV300			Not Used
XV301	94925	737867-14	Socket: tube, 7 pin
XV302, XV303	94926	737870-14	Socket: tube, 9 pin
XV304	68590	99100-4	Socket: tube, 8 pin
XV305 to XV400			Not Used
XV401	94925	737867-14	Socket: tube, 7 pin
XV402, XV403	94926	737870-14	Socket: tube, 9 pin
XV404	68590	99100-4	Socket: tube, 8 pin
			Miscellaneous:
	30075	737820-507	Knob: control
	212940	8905470-1	Plate: dial, numbered 0-10
	211776	8905465-6	Pointer: dial
	219282	486041-7	Terminal: standoff
	223112	8980161-501	Cable Assembly complete, unstenciled, (low capacity). Includes 2 coax connectors for use in any one of the following applications: 104J101 - 203J102; 104J202 - 203J202; 104J302 - 203J302; 104J402 - 203J402

TYPICAL TUBE SOCKET VOLTAGES*

Symbol	Tube Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V101	6485	0	1.4	6.3 ac	0	140	150	1.4	-	-
V102	6CL6	3.7	0	149	6.3 ac	0	210	3.7	149	0
V103	6973	210	0	0	6.3 ac	0	0	8.0	210	150
V104	6550	0	6.3 ac	200	230	0	0	0	14	-

* All voltages dc unless otherwise noted.
AC line voltage 117 volts ac.
Voltage measurements taken with VTVM; machine in SETUP mode.
Above measurements taken on channel 1; however, channels 2, 3, and 4 are the same as channel 1.



RESISTANCE VALUES ARE IN OHMS.
K=1000
CAPACITANCE VALUES ARE IN MF,
UNLESS OTHERWISE NOTED.
←— INDICATES CW ROTATION.

Figure VRA-6. Video Record Amplifier Schematic Diagram

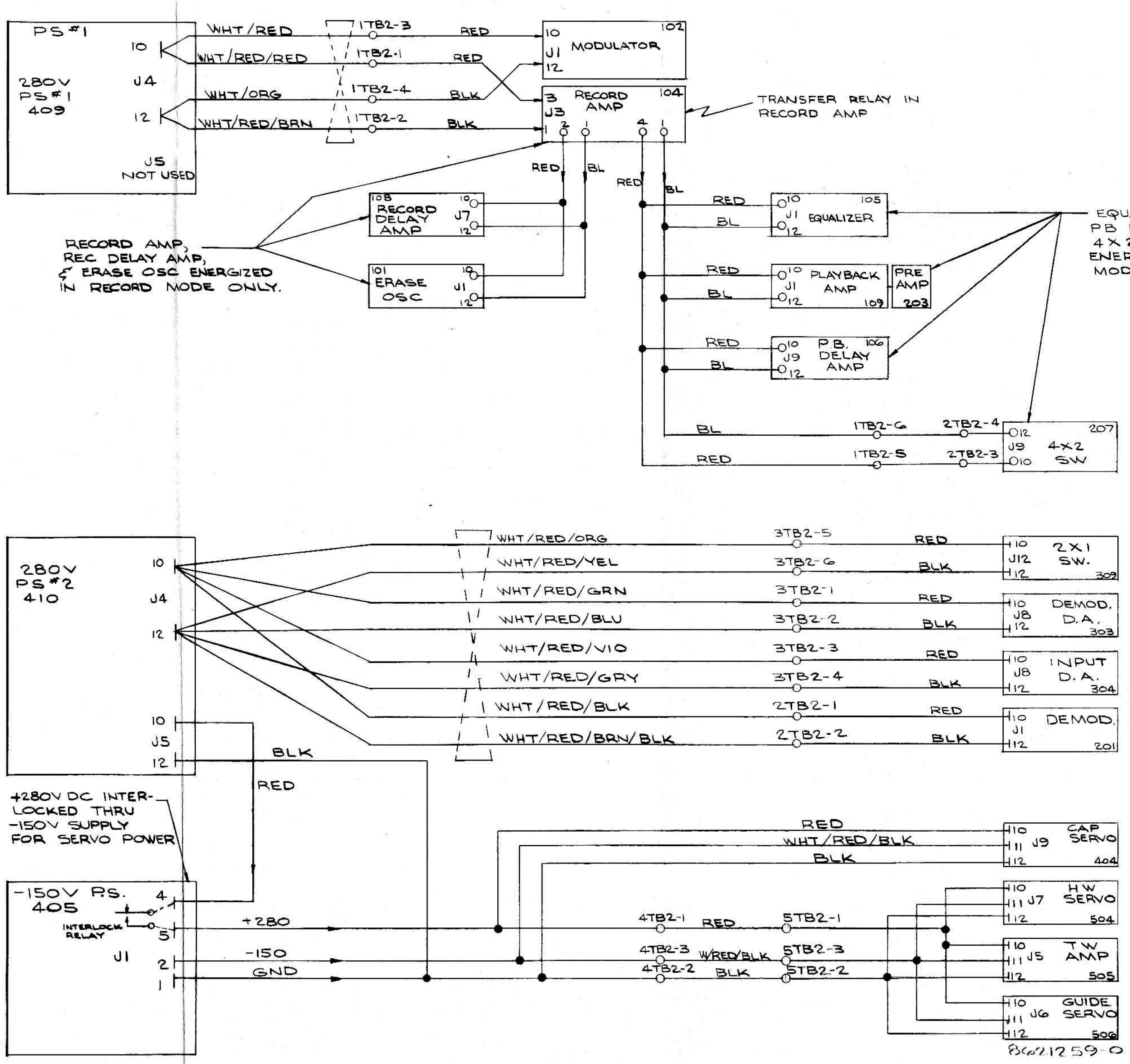


Figure VRA-7. DC Power Distribution Diagram

4 Channel Equalizer

UNIT 105

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
PP 661

IB-31135

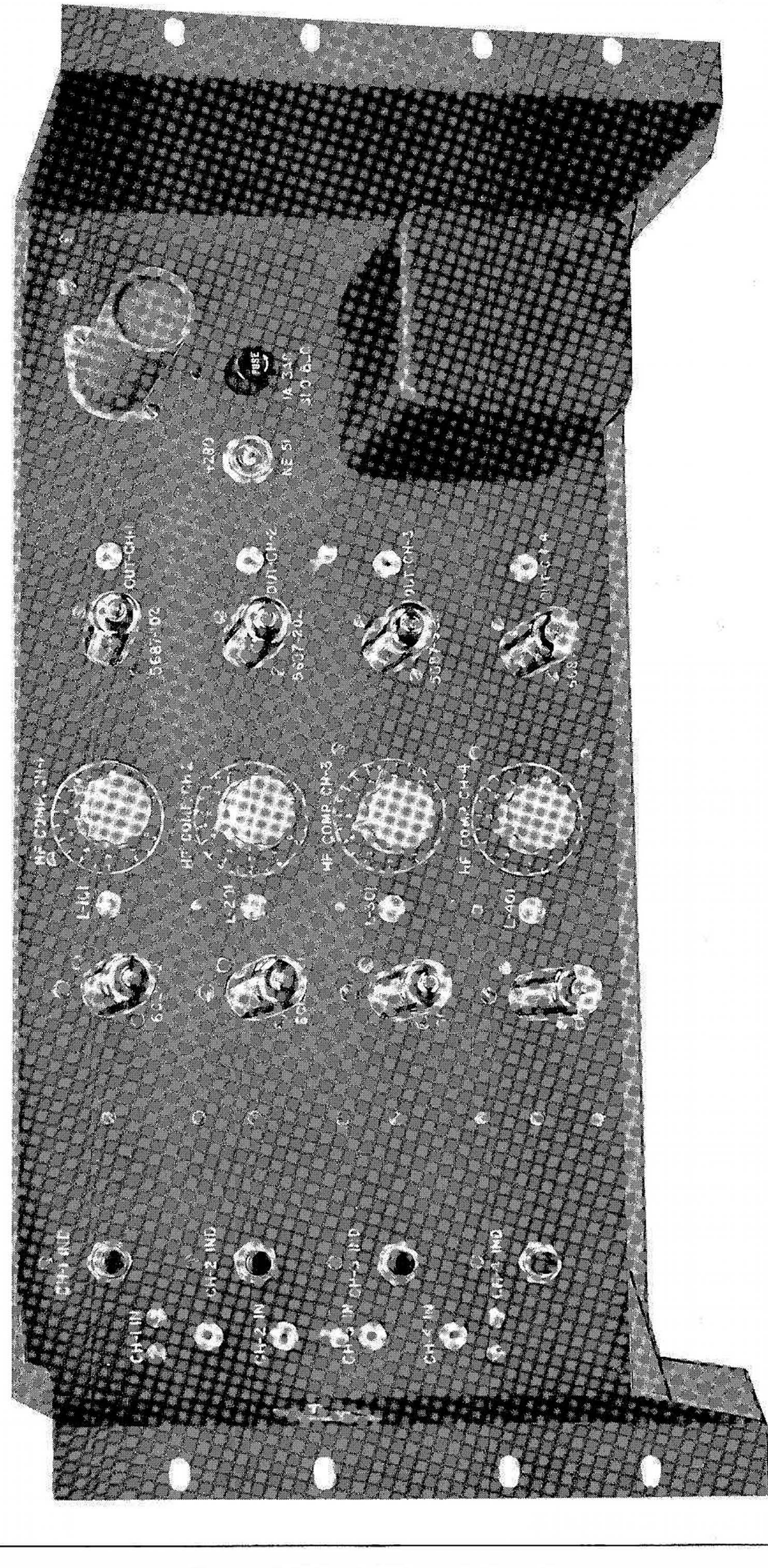


Figure EQ-1. 4 Channel Equalizer

TECHNICAL DATA

Power Required

Filament Transformer: 117 volts, 50/60 cps, 50 watts (from circuit breaker No. 1)

Plate: 280 volts dc, 190 ma (from power supply No. 1, unit 409)

Number of Amplifier Channels

Four (one for each video head in head wheel)

Input to Each Channel

FM signal from Playback Delay Amplifier (unit 106), 0.25 v peak-to-peak (nominal)

Output of Each Channel

FM signal to 4 x 2 Switcher, 0.5 v peak-to-peak (nominal)

Input Impedance

160 ohms (each channel, internal)

Output Load Impedance

160 ohms (each channel terminated at 4 x 2 Switcher)

Frequency Response

Variable—See Figure EQ-3E

Pilot Lamp

One NE-51 neon lamp

Fuse

1 amp 3AG SLO-BLO

Tube Complement

4 6CL6 (one for each channel)
4 5687 (one for each channel)

DESCRIPTION

The Four Channel Equalizer (see figure EQ-1) permits adjustment of the response of the fm playback system to compensate for differences in the frequency response of the individual video heads. In conjunction with the overall fm equalizer, in the 2 x 1 switcher, it also equalizes the fm information from the tape so that a flat video response is obtained after detection in the demodulator.

Each of the four equalizer channels consists of a shunt peaked video amplifier (see schematic diagram figure EQ-4) followed by a series amplifier used for driving the output line. The fm input signal to each equalizer channel is .25 volt peak-to-peak (see figure EQ-2A) from the playback delay amplifier. The outputs of the equalizer, which feed the 4 x 2 switcher, are 0.5 volt peak-to-peak (see figure EQ-2D).

Variable response is accomplished by a plate load potentiometer, such as R120 in channel 1, designated HF COMP. Figure EQ-2E, shows a composite response of the circuit when the pot is maximum CW, maximum CCW, and adjusted for a flat response. The crossover frequency of 5.5 mc minimizes the amplitude changes of the carrier. Varying the response, by adjusting R120, etc. changes the relative energy of the lower sideband as compared to the carrier. These changes result in high frequency video response variations after detection in the demodulator. Thus, the maximum ccw position of the potentiometer R120, etc., (figure EQ-2E, curve with maximum peaking at 8 mc) gives the lowest sideband energy which results in minimum high frequency video response after detection. Therefore, CW rotation of the potentiometer gives high frequency video peaking.

A momentary pushbutton is provided in each channel (S101 etc.) as a means of channel identification when testing. When the button is depressed, the output of the channel is reduced. This reduction is visible when monitoring the 2 x 1 switcher output on the CRO monitor. When the recorder is on the air, these buttons should not be pressed since signal reduction may be below the threshold of limiting and may be visible in the picture.

OPERATION

The four high frequency compensators (HF COMP, CH-1 etc.) are adjusted for equal high frequency response between channels when playing back a tape. Although these controls may be adjusted exactly with the playback of a multiburst test pattern, they are generally adjusted by observing the playback picture on the picture monitor.

For monochrome, the adjustments should be made to obtain maximum resolution of the vertical edges without overshoots (indicating excessive high peaking) and to eliminate bands due to unequal response in the four channels. For color, the adjustments should be made primarily to eliminate banding in the red area.

MAINTENANCE

Troubleshooting

A Tektronix 535 oscilloscope, or the equivalent, should be used whenever signal amplitudes require measurement. Figure EQ-2 shows typical waveforms for comparison. Since the four channels are identical,

a comparison may also be made between channels. Each channel has a gain of two, but the output voltage will depend on the amplitude of the input voltage. During troubleshooting, refer to schematic diagram, figure EQ-4.

If for any reason components are changed, or it is desired to check the sweep response of a channel, the following procedure should be observed.

(1) Remove input and output coaxial cables of channel to be swept.

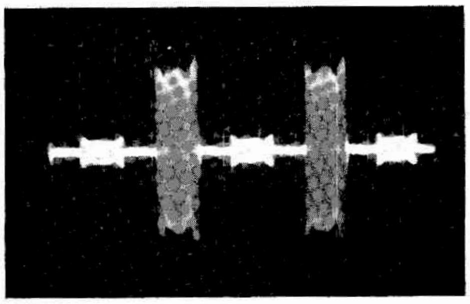
(2) Connect a 10 mc video sweep generator to the input. (The input is terminated in 160 ohms; if sweep requires lower impedance, an 80-ohm termination may be obtained by placing a clip lead between the inputs of two channels.) Adjust input for about .25 volt peak-to-peak.

(3) Terminate output with 75 ohms and connect a scope across the termination.

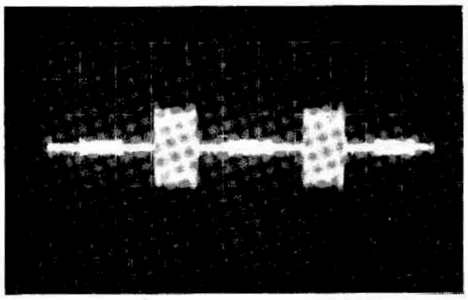
(4) The output amplitude should be approximately equal to the input, and should have a response similar to that shown in figure EQ-2E for maximum and minimum settings of HF control.

If necessary, adjust peaking coil L102 etc. to obtain maximum response at 7.5 mc when potentiometer is set to maximum ccw position.

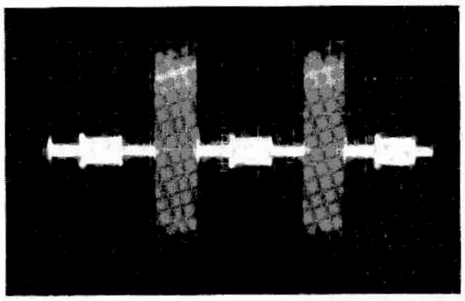
NOTES: 1. Equalizer waveforms taken with Tektronix Type 535 oscilloscope
2. All waveforms taken from CH-1 with direct probe



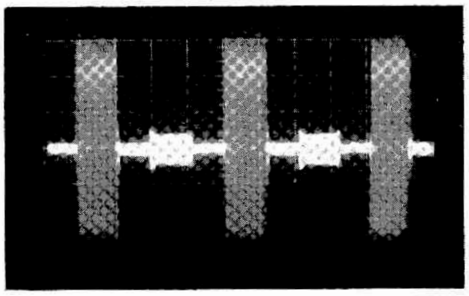
A. INPUT—TP101
.05 v/cm



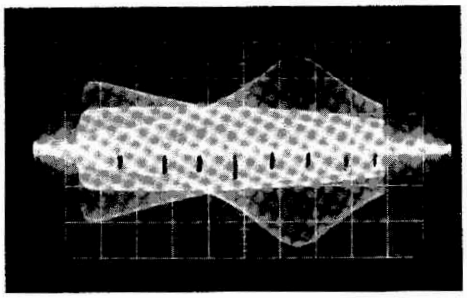
B. V101 pin 1, cathode
.05 v/cm



C. V102 pin 6, cathode
.05 v/cm



D. OUTPUT—TP102
0.1 v/cm



E. Sweep Input; Position of HF COMP CONT; CW, CCW and flat; 1 mc markers on base line, 3 mc on left, to 10 mc on right

Figure EQ-2. 4 Channel Equalizer, Waveforms

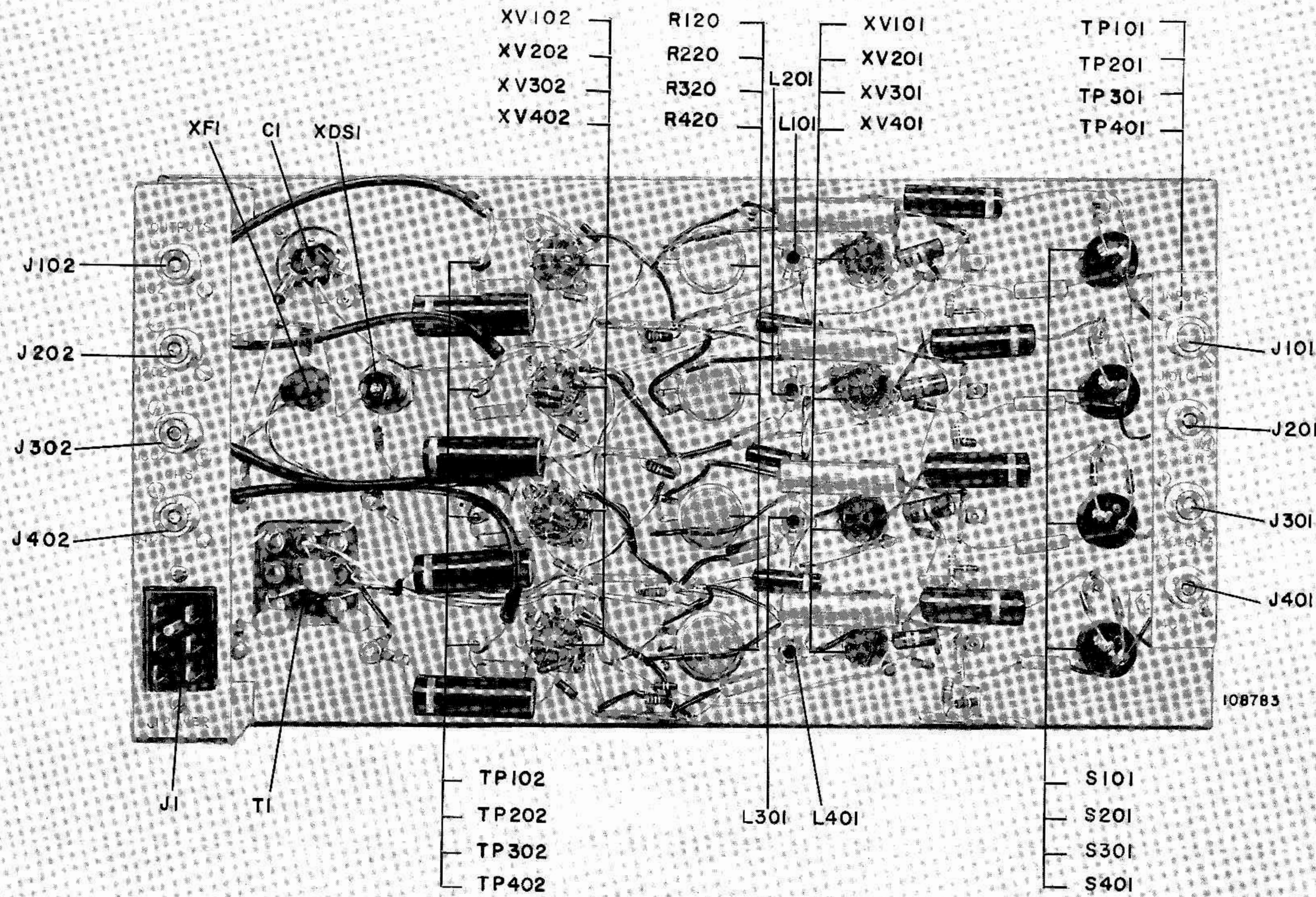


Figure EQ-3. 4 Channel Equalizer, Rear View

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
			EQUALIZER (8973690-503) 13
			CAPACITORS:
C1A, B	99295	458557-5	electrolytic, 20/20 μf +50 −10%, 450 v
C2		735715-179	paper, 0.22 μf ±10%, 400 v
C3 to C5		8811182-5	ceramic, 0.01 μf +100 −10%, 450 v
C6 to C100			Not Used
C101		735715-175	paper, 0.1 μf ±10%, 400 v
C102		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C103		735715-163	paper, 0.01 μf ±10%, 400 v
C104		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C105			Not Used
C106		735715-179	paper, 0.22 μf ±10%, 400 v
C107		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C108 to C200			Not Used
C201		735715-175	paper, 0.1 μf ±10%, 400 v
C202		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C203		735715-163	paper, 0.01 μf ±10%, 400 v
C204		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C205			Not Used
C206		735715-179	paper, 0.22 μf ±10%, 400 v
C207		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C208 to C300			Not Used
C302		735715-175	paper, 0.1 μf ±10%, 400 v
C302		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C303		735715-163	paper, 0.01 μf ±10%, 400 v
C304		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C305			Not Used
C306		735715-179	paper, 0.22 μf ±10%, 400 v
C307		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C308 to C400			Not Used
C401		735715-175	paper, 0.1 μf ±10%, 400 v
C402		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C403		735715-163	paper, 0.01 μf ±10%, 400 v
C404		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
C405			Not Used
C406		735715-179	paper, 0.22 μf ±10%, 400 v
C407		727856-147	mica, 1000 μμf ±10%, 300 v char "B"
DS1	101857	872291-9	Lamp: neon
F1	53447	990157-108	Fuse: 1 amp
J1	51604	727969-3	Connector: male, 6 contact, chassis mtg.
J2 to J100			Not Used
J101, J102	51800	255223-2	Connector: coax, chassis mtg.
J103 to J200			Not Used
J201, J202	51800	255223-2	Connector: coax, chassis mtg.
J203 to J300			Not Used
J301, J302	51800	255223-2	Connector: coax, chassis mtg.
J303 to J400			Not Used
J401, J402	51800	255223-2	Connector: coax, chassis mtg.
L101	210530	476933-4	Coil
L102 to L200			Not Used
L201	210530	476933-4	Coil
L203 to L300			Not Used
L301	210530	476933-4	Coil
L302 to L400			Not Used
L401	210530	476933-4	Coil.
P1	51607	727969-4	Connector: female, 6 contact, cable mtg.
P2 to P100			Not Used
P101, P102			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P103 to P200			Not Used

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
P201, P202			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979036-1	Adapter only
		8979036-3	Sleeve only
P203 to P300			Not Used
P301, P302			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8970037-1	Adapter only
		8979036-3	Sleeve only
P303 to P400			Not Used
P401, P402			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-85	82,000 ohm ±10%, ½ w
R2		82283-90	220,000 ohm ±10%, ½ w
R3		82283-94	470,000 ohm ±10%, ½ w
R4			Part of XDS1
R5		90496-111	10 ohm ±5%, 1 w
R6 to R104			Not Used
R105		99126-79	27,000 ohm ±10%, 2 w
R106		82283-92	330,000 ohm ±10%, ½ w
R107	218119	458574-59	wire wound, 3500 ohm ±5%, 10 w
R108			Not Used
R109		82283-46	47 ohm ±10%, ½ w
R110		82283-50	100 ohm ±10%, ½ w
R111		82283-92	330,000 ohm ±10%, ½ w
R112 to R114		82283-54	220 ohm ±10%, ½ w
R115 to R117		82283-50	100 ohm ±10%, ½ w
R118		82283-38	10 ohm ±10%, ½ w
R119		82283-140	160 ohm ±5%, ½ w
R120	95754	433196-11	variable, 2000 ohm ±10%, 2 w
R121		82283-141	180 ohm ±5%, ½ w
R122 to R204			Not Used
R205		99126-79	27,000 ohm ±10%, 2 w
R206		82283-92	330,000 ohm ±10%, ½ w
R207	218119	458574-59	wire wound, 3500 ohm ±5%, 10 w
R208			Not Used
R209		82283-46	47 ohm ±10%, ½ w
R210		82283-50	100 ohm ±10%, ½ w
R211		82283-92	330,000 ohm ±10%, ½ w
R212 to R214		82283-54	220 ohm ±10%, ½ w
R215 to R217		82283-50	100 ohm ±10%, ½ w
R218		82283-38	10 ohm ±10%, ½ w
R219		82283-140	160 ohm ±5%, ½ w
R220	95754	433196-11	variable, 2000 ohm ±10%, 2 w
R221		82283-141	180 ohm ±5%, ½ w
R222 to R304			Not Used
R305		99126-79	27,000 ohm ±10%, 2 w
R306		82283-92	330,000 ohm ±10%, ½ w
R307	218119	458574-59	wire wound, 3500 ohm ±5%, 10 w
R308			Not Used
R309		82283-46	47 ohm ±10%, ½ w
R310		82283-50	100 ohm ±10%, ½ w
R311		82283-92	330,000 ohm ±10%, ½ w
R312 to R314		82283-54	220 ohm ±10%, ½ w
R315 to R317		82283-50	100 ohm ±10%, ½ w
R318		82283-38	10 ohm ±10%, ½ w
R319		82283-140	160 ohm ±5%, ½ w
R320	95754	433196-11	variable, 2000 ohm ±10%, 2 w
R321		82283-141	180 ohm ±5%, ½ w
R322 to R404			Not Used

Symbol No.	Stock No.	Drawing No.	Description
R405		99126-79	27,000 ohm ±10%, 2 w
R406		82283-92	330,000 ohm ±10%, ½ w
R407	218119	458574-59	wire wound, 3500 ohm ±5%, 10 w
R408			Not Used
R409		82283-46	47 ohm ±10%, ½ w
R410		82283-50	100 ohm ±10%, ½ w
R411		82283-92	330,000 ohm ±10%, ½ w
R412 to R414		82283-54	220 ohm ±10%, ½ w
R415 to R417		82283-50	100 ohm ±10%, ½ w
R418		82283-111	10 ohm ±5%, ½ w
R419		82283-140	160 ohm ±5%, ½ w
R420	95754	433196-11	variable, 2000 ohm ±10%, 2 w
R421		82283-141	180 ohm ±5%, ½ w
S101	59509	8861341-1	Switch: push, N.O.
S102 to S200			Not Used
S201	59509	8861341-1	Switch: push, N.O.
S202 to S300			Not Used
S301	59509	8861341-1	Switch: push, N.O.
S302 to S400			Not Used
S401	59509	8861341-1	Switch: push, N.O.
TP101, TP102	208983	8825493-7	Jack: tip
TP103 to TP200			Not Used
TP201, TP202	208983	8825493-7	Jack: tip
TP203 to TP300			Not Used
TP302, TP302	208983	8825493-7	Jack: tip
TP303 to TP400			Not Used
TP401, TP402	208983	8825493-7	Jack: tip
T1	94713	443975-3	Transformer: filament
XADS1	208080	990788-507	Jewel
XDS1	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Fuse: holder
XV101, XV102	94926	737870-14	Socket: tube, 9 pin
XV103 to XV200			Not Used
XV201, XV202	94926	737870-14	Socket: tube, 9 pin
XV203 to XV300			Not Used
XV301, XV302	94926	737870-14	Socket: tube, 9 pin
XV303 to XV400			Not Used
XV401, XV402	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	99244	8849946-1	Knob: red
	212940	8905470-1	Plate: dial
	211776	8905465-6	Pointer: adjustable

4 CHANNEL EQUALIZER, VOLTAGE CHART

All readings dc unless otherwise indicated.

Symbol	Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V101	6CL6	4.8	—	—	6.3ac	6.3ac	180	4.8	108	3.3
V102	5687	275	140	145	6.3ac	6.3ac	4.5	0	6.3ac	140

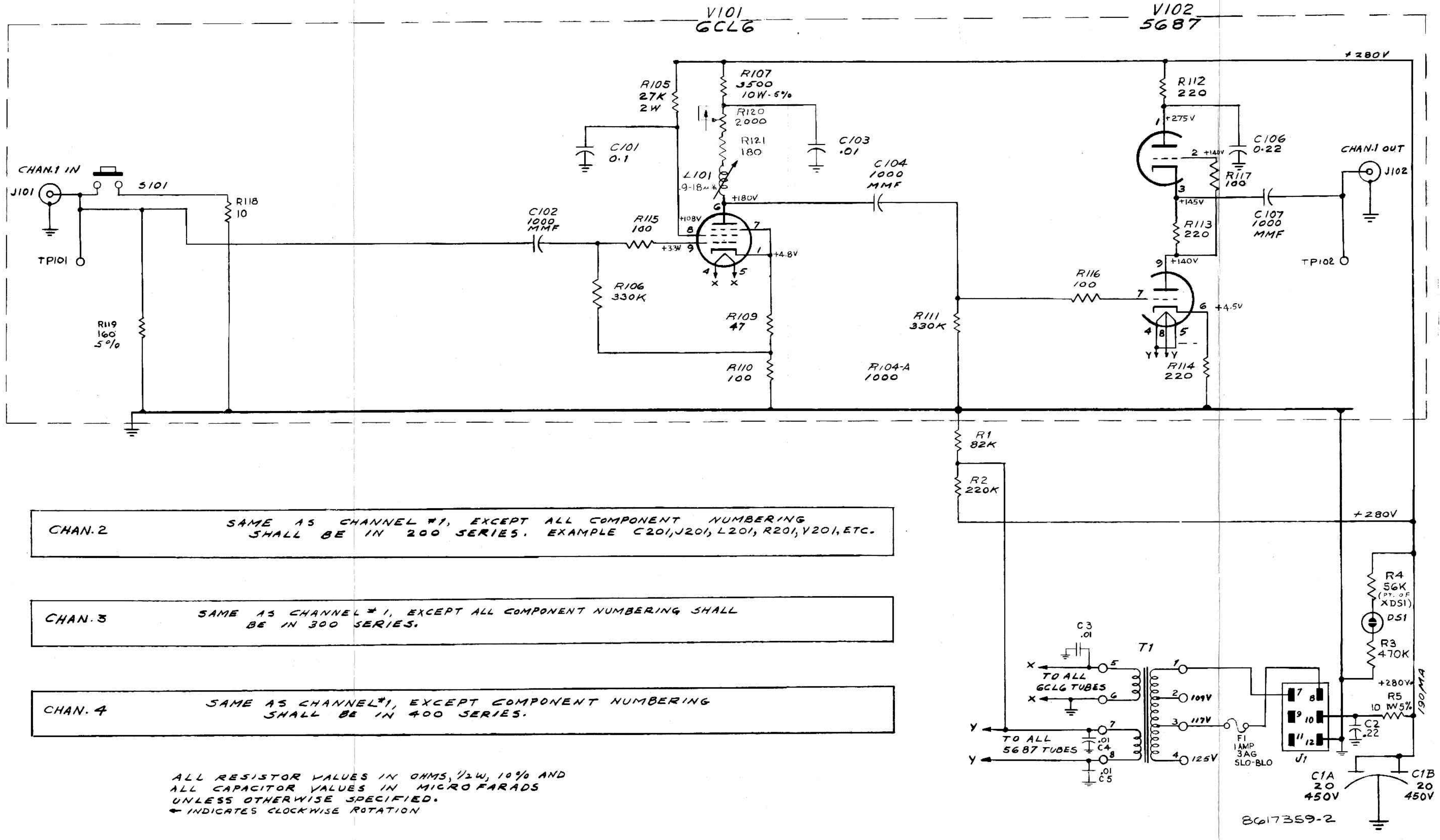


Figure EQ-4. 4 Channel Equalizer, Schematic Diagram

Playback Delay Amplifier

UNIT 106

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 671

IB-31136

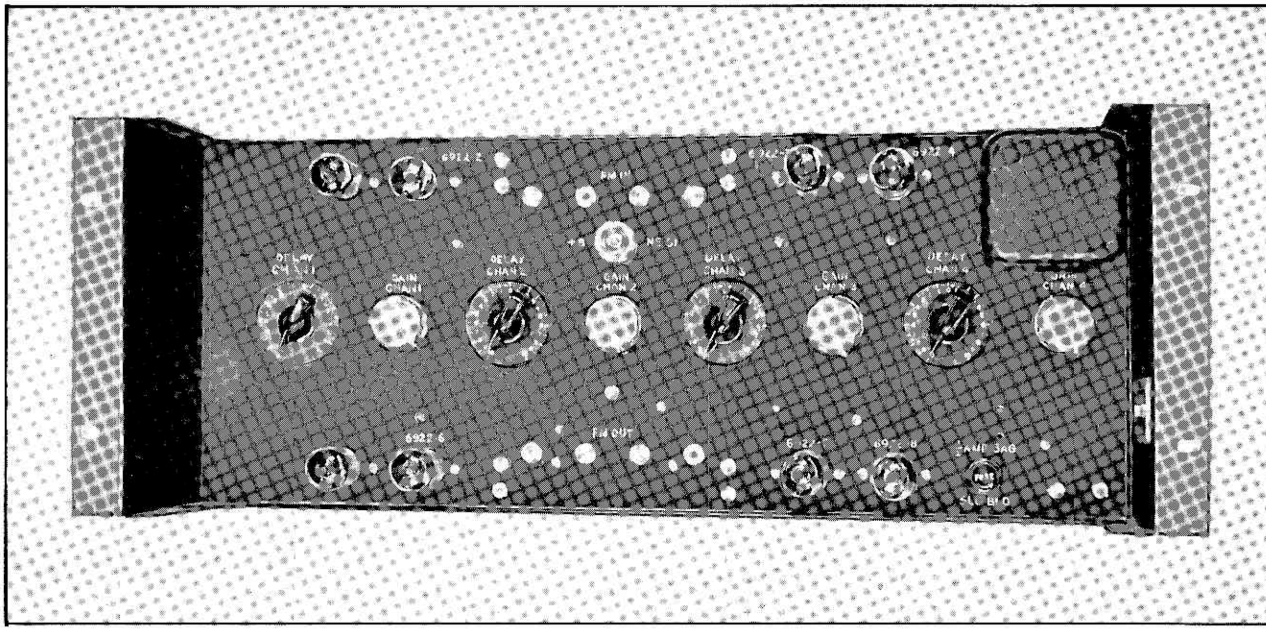


Figure PDA-1. Playback Delay Amplifier

TECHNICAL DATA

Power Required

Filament Transformer: 117 volts, 50/60 cps (from circuit breaker No. 1)

Plate: 280 volts dc, 170 ma (from power supply No. 1, unit 409)

Input Voltage to Each Channel

0.25 volt peak-to-peak
(f-m signal output of playback amplifier)

Number of Amplifier Channels

Four

Output of Each Channel

Delayed f-m signal to Equalizer Chassis, 0.25 volt peak-to-peak

Number of Test Points

Eight (one input and one output for each channel)

Line Terminations

Input: 160 ohms (internal)

Output: 160 ohms (on equalizer chassis)

Adjustable Delay in Each Channel

20 steps, 0.015 microsecond per step

Tube Complement

8 6922 tubes

Pilot Lamp

One NE-51, neon lamp

Fuse (in filament transformer primary)

½ amp, Slo-Blo

DESCRIPTION

The Playback Delay Amplifier (see figure PDA-1) is used in the playback mode of operation to correct for two possible sources of errors; a playback headwheel containing heads not in exact quadrature relationship, and improperly made tapes where the effective spacing between heads was not within quadrature specifications.

Quadrature errors appear in a television tape picture as horizontally displayed bands of segments 16 or 17 lines high. These displacements are extremely noticeable in sharp vertical lines in the picture. Refer to the instructions of the *Record Delay Amplifier* for a discussion concerning quadrature errors and methods of correction. In both the record delay amplifier and playback delay amplifier, tapped delay lines are utilized to correct quadrature errors.

The input of each channel is fed from the playback amplifier, through 160 ohm impedance cables, to the playback delay amplifier where each line is internally terminated with a total of 160 ohms of which the input gain control is a part.

Circuit

Refer to the schematic diagram, figure PDA-5. Four identical channels are contained in the playback delay amplifier. A cathode follower drives a 20 section (0.15 μsec. per section) delay line, and the arm of each delay line switch feeds the grid of a line driver amplifier.

OPERATION

There are two adjustments for each channel, GAIN and DELAY. Adjustment of the four input gain potentiometers is made while observing the 2 X 1 OUT on the CRO waveform monitor. Adjust each channel amplitude to the 100 IRE units (140 IRE units being equal to 1 volt).

Adjustment of the four DELAY knobs corrects for two conditions: quadrature error in the headwheel and quadrature errors recorded on the tape. To correct for the first condition (quadrature errors in the headwheel) play back the standard alignment tape and adjust the DELAY knob on the playback delay amplifier to eliminate horizontal displacements in the vertical line as observed on the waveform monitor. Once the proper setting has been found, it is possible to "jump tracks" by adjusting the Control Track Phase and still maintain proper quadrature. Record the dial settings of the DELAY control knobs; these are the points where a properly recorded tape will play back with no quadrature errors apparent in the picture. Remove the alignment tape from the machine.

The delay adjustments may be utilized to correct quadrature errors recorded on a tape. Play back the tape and adjust the delay switches on the playback amplifier to eliminate the quadrature displacements. Once the tape has been removed from the machine, it is necessary to return the DELAY controls to the normal positions as determined by the previous adjustments utilizing the standard alignment tape.

MAINTENANCE

Routine maintenance should include a periodic check of tubes, and the selector switches should be rotated through their ranges each time the unit is set up for a given panel. This will clean the contact material which helps to assure trouble free operation.

Troubleshooting

Since four identical channels are contained in this unit, troubles may be easily located by simply comparing channels. A voltage charge in figure PDA-5 should be used as a reference when checking voltages.

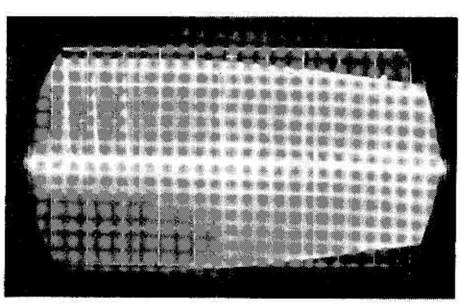
Figure PDA-3 shows waveforms which were taken when the machine was in normal operation. Reference should be made to these waveforms when checking out a channel.

The waveform monitor located in rack 3 may be used for fast troubleshooting when channels are to be compared; however, for more accurate measurements, an oscilloscope such as a Tektronix Type 524 or 535A is required.

Low frequency smear on one channel is generally caused by a defective component in the delay line assembly. To check the performance of a channel, feed a sweep signal into the input and observe the response at various points along the channel. Some specific points of test can be compared with the waveforms in figure PDA-3. Excessive ripple is an indication of delay line malfunctioning caused by a defective component.

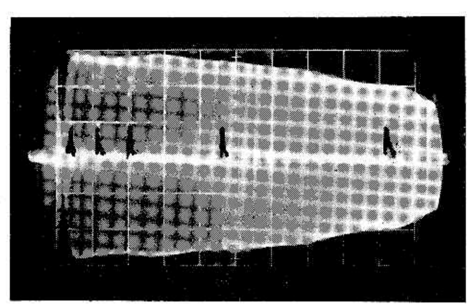
Figure PDA-2 shows the sweep performance for any one channel of the playback delay amplifier. All four channels should be the same.

NOTES: 1. Waveforms taken with Tektronix Type 535A oscilloscope with low capacity probe (11.5 $\mu\mu$f).



1mc 2mc 3mc 5mc 10mc

A. INPUT-TP1, TP2, TP3 or TP4
.1 volt/div.

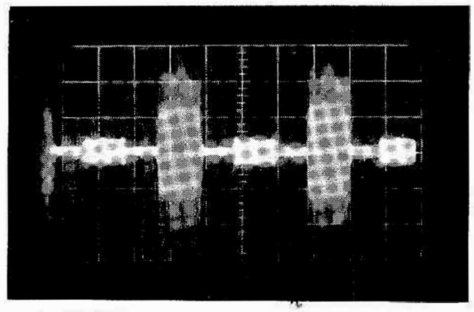


1mc 2mc 3mc 5mc 10mc

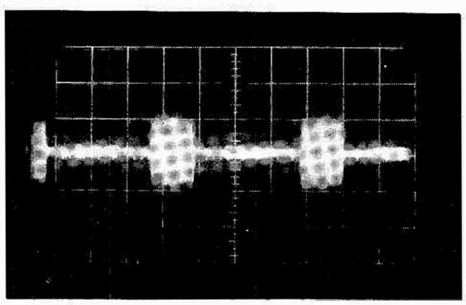
B. OUTPUT-TP5, TP6, TP7 or TP8
.1 volt/div.

Figure PDA-2. Playback Delay Amplifier, Input and Output Sweep Response

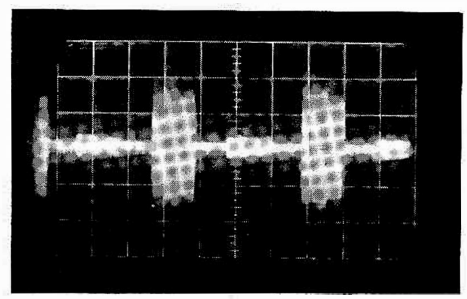
NOTES: 1. Waveforms taken with Tektronix Type 535A oscilloscope with low capacity probe (11.5 $\mu\mu f$).
2. All waveforms have the same time base, 1 millisecond/cm.
3. Waveforms taken of channel 1; also typical for other three channels.



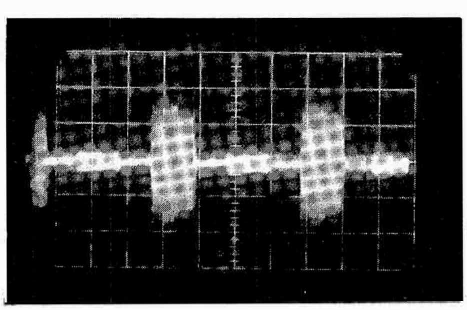
A. INPUT J4 **(.2v/div.)**



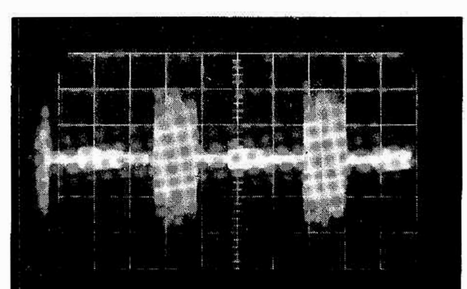
B. TP4 **(.2v/div.)**



C. V1 pin 3, Cathode **(.05v/div.)**



D. V5 pin 7 Delay Line Output **(.05v/div.)**



E. Output-TP8 Channel 1 **(.05v/div.)**

Figure PDA-3. Playback Delay Amplifier, Waveforms and Voltage Levels

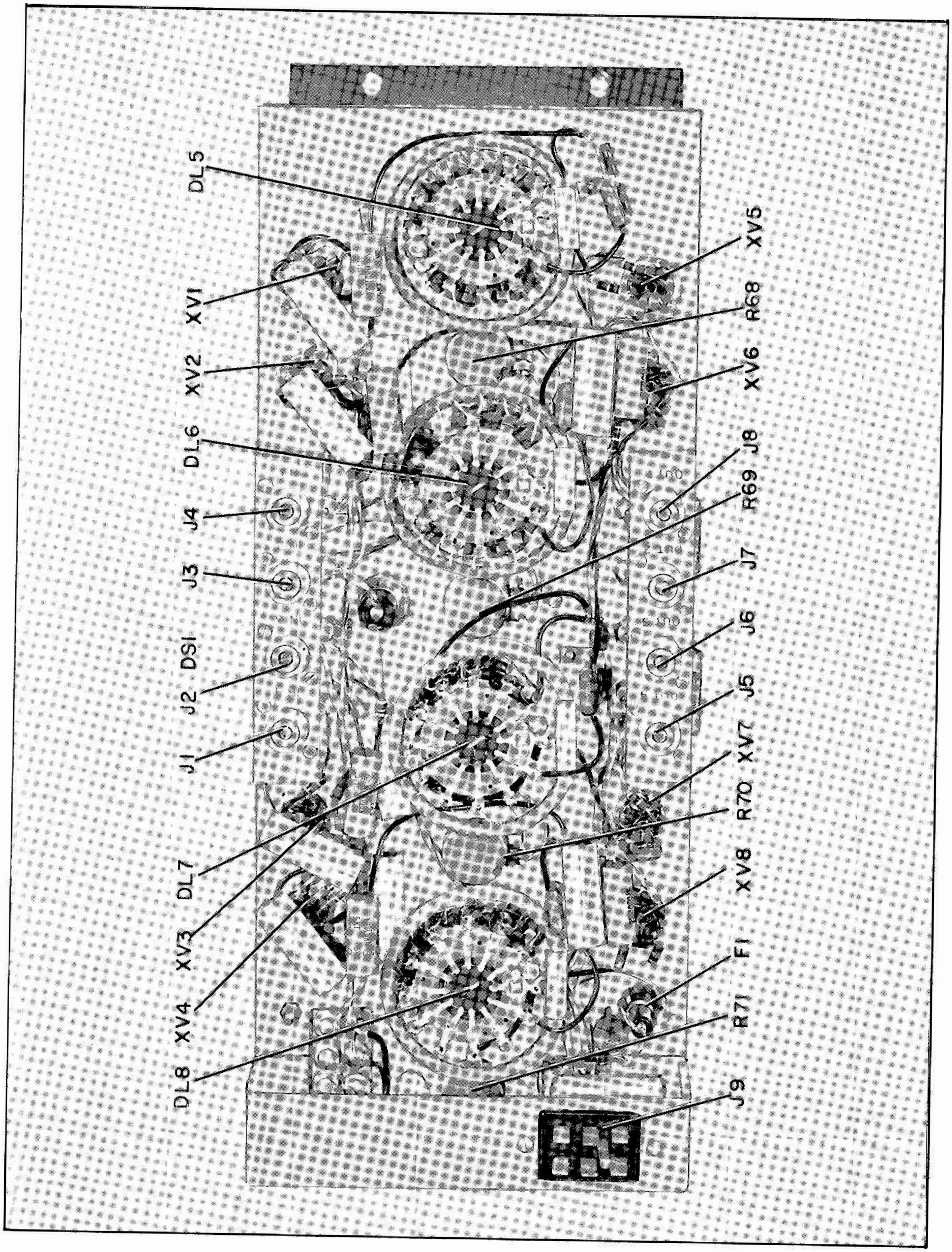


Figure PDA-4. Playback Delay Amplifier, Component Identification

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
PLAYBACK DELAY AMPLIFIER (8974489-502)			5
			CAPACITORS:
C1 to C7		735715-175	paper, 0.1 μ ±10%, 400 v
C8 to C27			Not Used
C28		727851-127	mica, 150 μμf ±10%, 500 v char "B"
C29		735715-175	paper, 0.1 μf ±10%, 400 v
C30		727851-127	mica, 150 μμf ±10%, 500 v char "B"
C31		735715-175	paper, 0.1 μf ±10%, 400 v
C32		727851-127	mica, 150 μμf ±10%, 500 v char "B"
C33		735715-175	paper, 0.1 μf ±10%, 400 v
C34		727851-127	mica, 150 μμf ±10%, 500 v char "B"
C35, C36		735715-175	paper, 0.1 μf ±10%, 400 v
C37		8811182-5	ceramic, 0.01 μf +100 -20%, 450 v
C38		735715-175	paper, 0.1 μf ±10%, 400 v
C39		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C40		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C41		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C42		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C43		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C44		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C45		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C46		727853-228	mica, 160 μμf ±5%, 500 v char "D"
DL1 to DL4			Not Used
DL5 to DL8	219886	8979723-502	Line: delay
	218245	727853-335	Capacitor: mica, 330 μμf ±2%, 500 v (Pt. of DL5 to DL8)
DS1	101857	872291-9	Lamp: neon
F1	212327	990157-106	Fuse: ½ amp
J1 to J8	51800	255223-2	Connector: coax, chassis mtg.
J9	51604	727969-3	Connector: male, 6 contact, chassis mtg.
P1 to P8			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P9	51607	727969-4	Connector: female, 6 contact, cable mtg.
			RESISTORS:
			Fixed, composition - unless otherwise specified
R1 to R3			Not Used
R4	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R5 to R8			Not Used
R9	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R10 to R13			Not Used
R14	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R15 to R18			Not Used
R19	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R20 to R48			Not Used
R49		82283-46	47 ohm ±10%, ½ w
R50			Not Used
R51	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R52, R53		82283-46	47 ohm ±10%, ½ w
R54			Not Used
R55	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R56, R57		82283-46	47 ohm ±10%, ½ w
R58			Not Used
R59	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R60, R61		82283-46	47 ohm ±10%, ½ w
R62			Not Used
R63	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R64		82283-46	47 ohm ±10%, ½ w
R65		82283-111	10 ohm ±5%, ½ w
R66			Part of XDS1
R67		82283-94	470,000 ohm ±10%, ½ w
R68 to R71	95245	8971860-4	variable, 250 ohm ±10%, 2 w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R72	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R73	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R74	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R75	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R76	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R77	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R78	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R79	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R80 to R83			Not Used
R84 to R87		82283-134	91 ohm ±5%, ½ w
R88 to R91		82283-150	430 ohm ±5%, ½ w
R92 to R99		82283-54	220 ohm ±10%, ½ w
T1	57021	949069-1	Transformer
TP1 to TP8	208983	8825493-7	Jack: tip yellow
V1 to V8	219675		Tube: type #6922
XADS1	208080	990788-507	Jewel
XDS1	208458	990789-5	Socket: lamp
XF1	48894	99088-2	Holder: fuse
XV1 to XV8	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	99244	8849946-1	Knob: red

NOTES

VOLTAGE CHART, PLAYBACK DELAY AMPLIFIER

NOTES: 1. Voltage measurements taken with a Voltohmyst.
2. Machine in STOP mode.
3. AC line voltage 117 volts, 60 cycles.
4. All voltages dc except where noted.

Tube Symbol	*Tube Type*	*Pin Number*								
		1	2	3	4	5	6	7	8	9
V1	6922	100	0	1.8	6.3 ac	0	100	0	1.8	0
V2	6922	100	0	1.8	6.3 ac	0	100	0	1.8	0
V3	6922	100	0	1.8	6.3 ac	0	100	0	1.8	0
V4	6922	100	0	1.8	6.3 ac	0	100	0	1.8	0
V5	6922	80	.9	1.9	6.3 ac	0	80	.9	1.9	0
V6	6922	80	.9	1.9	6.3 ac	0	80	.9	1.9	0
V7	6922	80	.9	1.9	6.3 ac	0	80	.9	1.9	0
V8	6922	80	.9	1.9	6.3 ac	0	80	.9	1.9	0

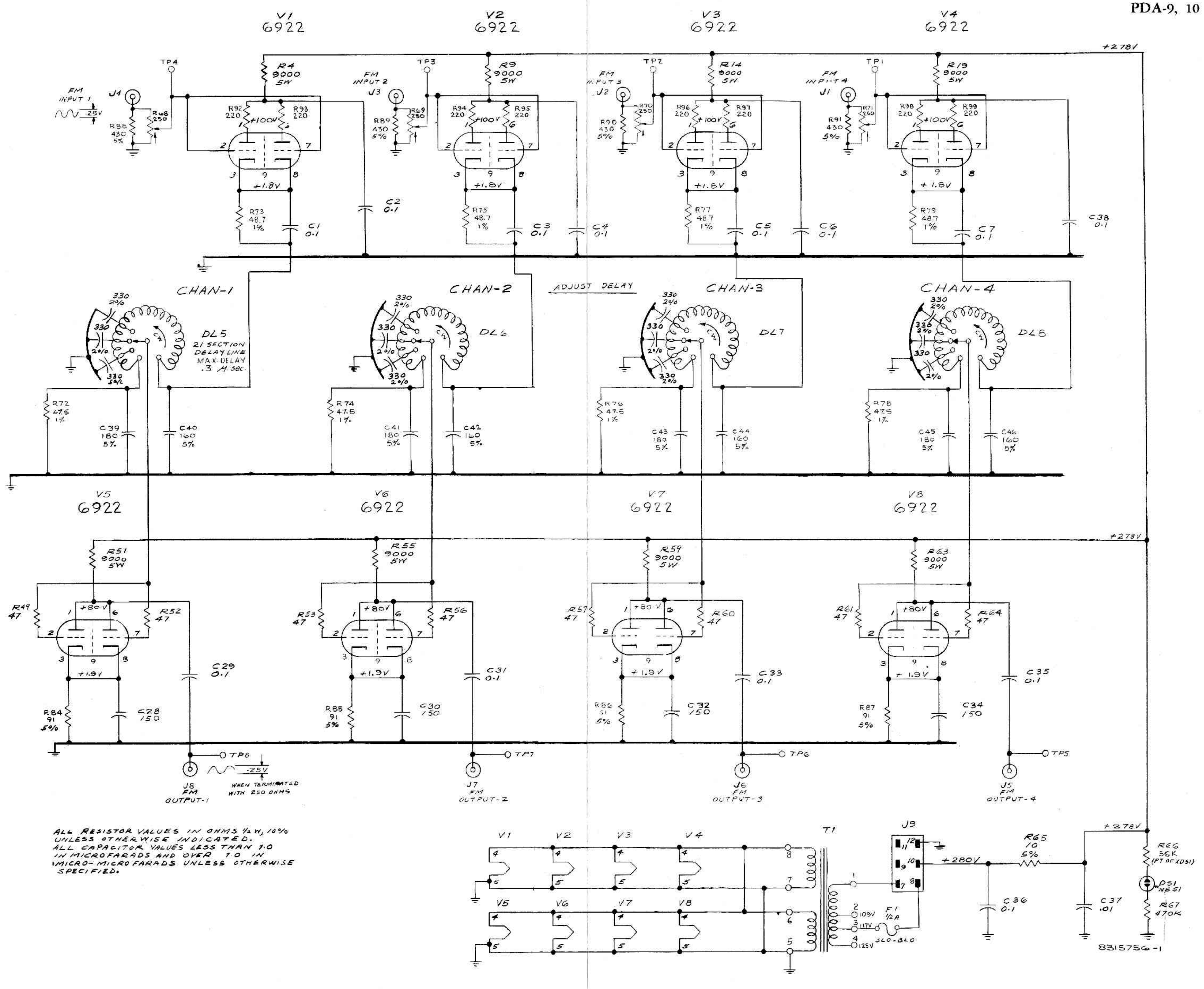


Figure PDA-5. Schematic Diagram, Playback Delay Amplifier

Record Delay Amplifier

UNIT 108

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

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WA 671

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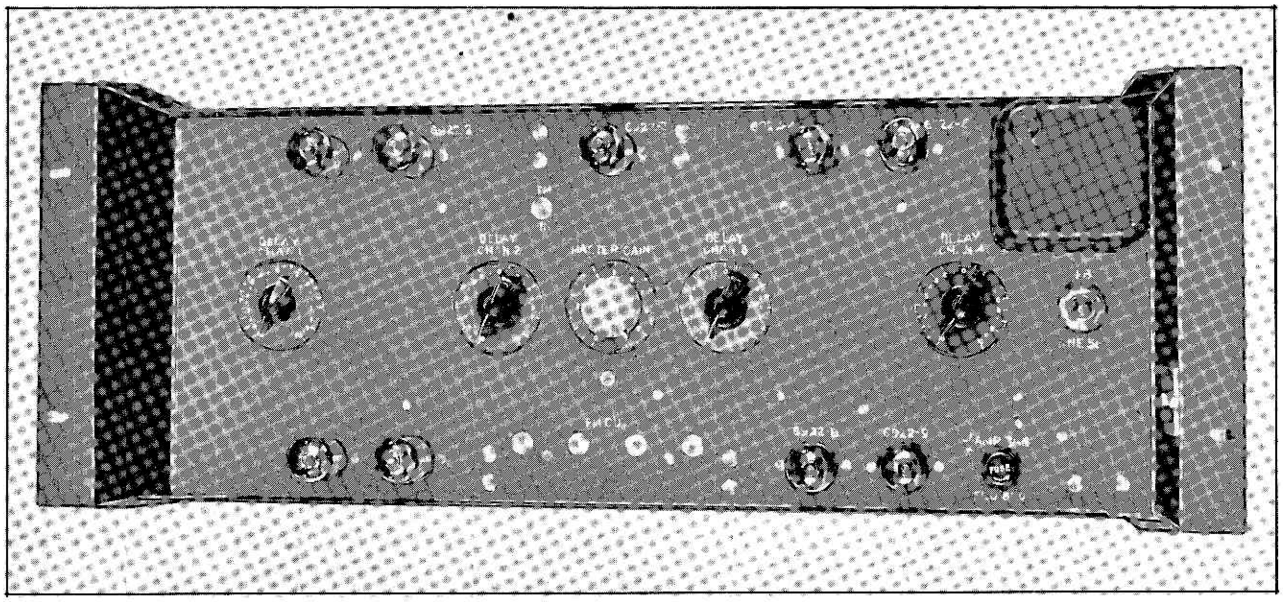


Figure RDA-1. Record Delay Amplifier

TECHNICAL DATA

Power Required

AC Power: 117 volts, 50/60 cps
(from circuit breaker No. 1)

DC Power: 280 volts dc, 180 ma
(from power supply, No. 1, unit 409)

Input Voltage

1.0 volt peak-to-peak
(single f-m output of modulator, unit 102)

Number of Amplifier Channels

Four

Output of Each Channel

Delayed f-m signal to Record Amplifier, 0.2 volt nominal peak-to-peak (when terminated with 75 ohms)

Number of Test Points

5 (one at input; one for each output)

Line Terminations

Input: External 75 ohms
Output: 75 ohms at Record Amplifier

Adjustable Delay in Each Channel

20 steps, 0.015 microsecond per step

Tube Complement

9 6922 tubes

Frequency Response

1 mc to 10 mc

Pilot Lamp

One NE-51, neon lamp

Fuse (in filament transformer primary)

½ amp, Slo-Blo, 3AG

DESCRIPTION

The Record Delay Amplifier (see figure RDA-1) aids in the production of recordings which will have proper quadrature relationship between tracks. To make proper recordings, the effective spacing between heads in the headwheel must theoretically be exactly 90 degrees.

The effective spacing between the heads may be adjusted either mechanically or electrically. Both methods are utilized with the TRT-1 recorders: in the factory the heads are spaced to within a few seconds of the correct 90 degree position, and then in the tape machine, final trimming is done electrically with the Record Amplifier. This operation is illustrated in figure RDA-2. Note that head no. 2 is out of position by x seconds angle. A recording made with this "wheel" (illustrated drawing) and played back with a perfect wheel, will produce pictures with horizontal displacement as illustrated in figure RDA-3. Since head no. 2 is displaced in a direction of counter rotation from the proper position, the information

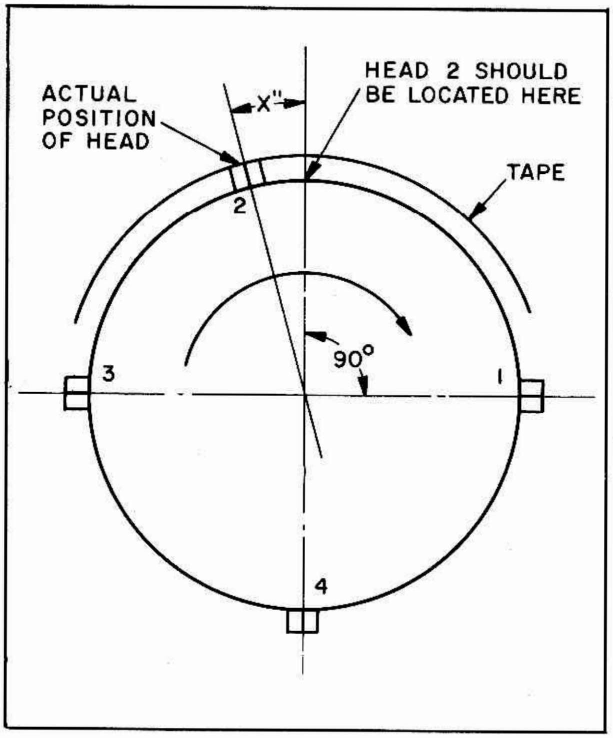


Figure RDA-2. Illustration of Video Head Placement Showing Head No. 2 Out of Quadrature

recorded will be late in time. Therefore if the signal feeding the late head is advanced in time by an amount equal to the mechanical displacement, the information recorded on tape will be recorded in the proper position. This advancing or delaying of the signals to the heads, is then the function of the record delay amplifier.

In the TRT-1B machine, the fm signal is fed from the demodulator (unit 201) to the record delay amplifier where the coaxial cable is terminated with an external 75-ohm resistor. The signal from the demodulator originates at the modulator, or the demodulator in another machine as is the case for r-f copy operation. The source switching occurs in the demodulator of the recording machine.

The four outputs of the record delay amplifier are fed to the record amplifier through 75 ohm coaxial cables. Internal 75 ohm terminations are contained in the record amplifier.

The main components in the record delay amplifier are the four 20 section delay lines with each section connected to a tap switch. The delay for each section is .015 microsecond which corresponds to about 6 seconds of arc on the headwheel. The dial calibration on each of the four delay lines is arranged so that

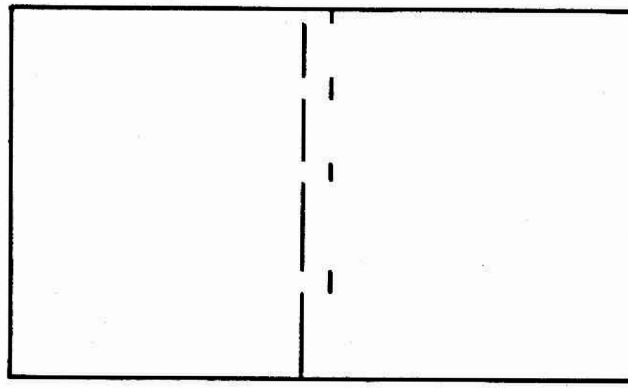


Figure RDA-3. Illustration of Vertical Line on TV Raster Showing Horizontal Displacement of Head No. 2

"0" is in the center. This permits the advance or delay of a signal in a given channel.

Circuit

Refer to schematic diagram figure RDA-7. Four identical channels are contained in the record delay amplifier. The output of each channel drives one of four inputs in the record amplifier (unit 104). A single cathode follower provides an adjustable drive signal to four cathode followers which contain the tapped delay lines in their cathode circuits. The arm of each switch, about which the delay line is built, feeds an output amplifier which is terminated with a 75-ohm load in the record amplifier.

OPERATION

A standard alignment tape is required to properly set up the positions of the four switches in the unit. Play back the alignment tape and adjust the switches in the playback delay amplifier to eliminate quadrature errors. Note the positions of the switches on the playback amplifier and set the respective delay switches in the record delay amplifier to the same number but *opposite* polarity. See the table on Typical Delay Settings.

TYPICAL DELAY SETTINGS

Unit	*Ch. 1*	*Ch. 2*	*Ch. 3*	*Ch. 4*
PLAYBACK DELAY	+3	0	−1	−2
RECORD DELAY	−3	0	+1	+2

Remove the standard alignment tape from the machine and install a tape on which a recording may be made.

Record a test pattern; rewind, and play back the recording. The vertical lines in the picture should contain a minimum of quadrature errors when played back on any track as adjusted by the CONTROL TRACK PHASE knob on the control panel. Large displacements indicate that the corrections should be rechecked.

MAINTENANCE

Routine maintenance should include a periodic check of tubes. In addition, the selector switches should be rotated through their ranges each time the unit is set up for a given headwheel panel. This will clean the contact material and help to assure trouble-free operation.

Troubleshooting

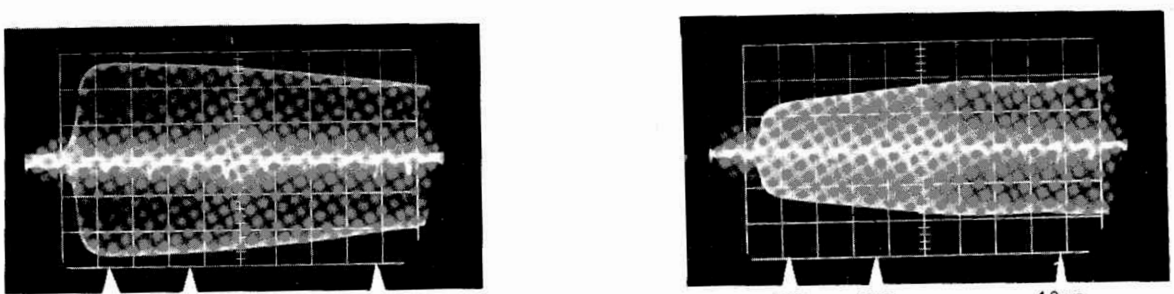
Since four identical channels are contained in this unit, one channel may be compared with another if below par performance is suspected. A voltage table in figure RDA-7, and a waveform and chart in figure RDA-5 should be helpful when troubleshooting.

The CRO waveform monitor in rack 3 may be used for fast troubleshooting when channels are to be compared; however, for more accurate measurements, a scope such as a Tektronix Type 524 or 535A is required.

Low frequency smear on any one channel can result from a defective component in the delay line assembly; if suspicious, check the performance of that channel.

To check the performance of a channel, feed a sweep signal into the input and observe the response at various points along the channel (see figure RDA-5). Excessive ripple is an indication of delay line malfunction caused by a defective component. Refer to figure RDA-4 for the sweep performance of the record delay amplifier.

NOTES: 1. Waveforms taken with Tektronix Type 535A.
2. Low capacity probe (11.5 $\mu\mu f$).

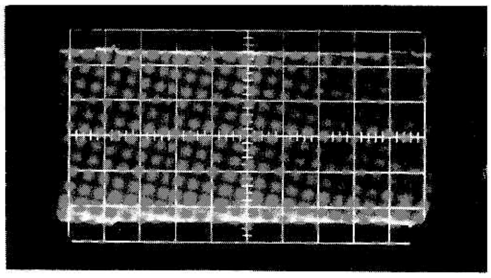


A. INPUT TP2 **(.1v/div.)**

B. OUTPUT **(.05v/div.)**
Measured at Record Amplifier inputs, TP-101, 201, 301, and 401

Figure RDA-4. Record Delay Amplifier, Input and Output Sweep Response

NOTES: 1. Taken with Tektronix Type 535A oscilloscope with high gain preamplifier (11.5 $\mu\mu f$ probe).
2. Scope locked to Vertical sync.
3. This waveform appears at the points listed in the table below with the different voltages given.



Observation Point	*Volts (peak-to-peak)*
TP-2	1.0
V3 pin 8	0.8
V1 pin 8	0.4
V6 pin 7	0.4
TP-6	0.4

Figure RDA-5. Record Delay Amplifier, Waveform Voltage References

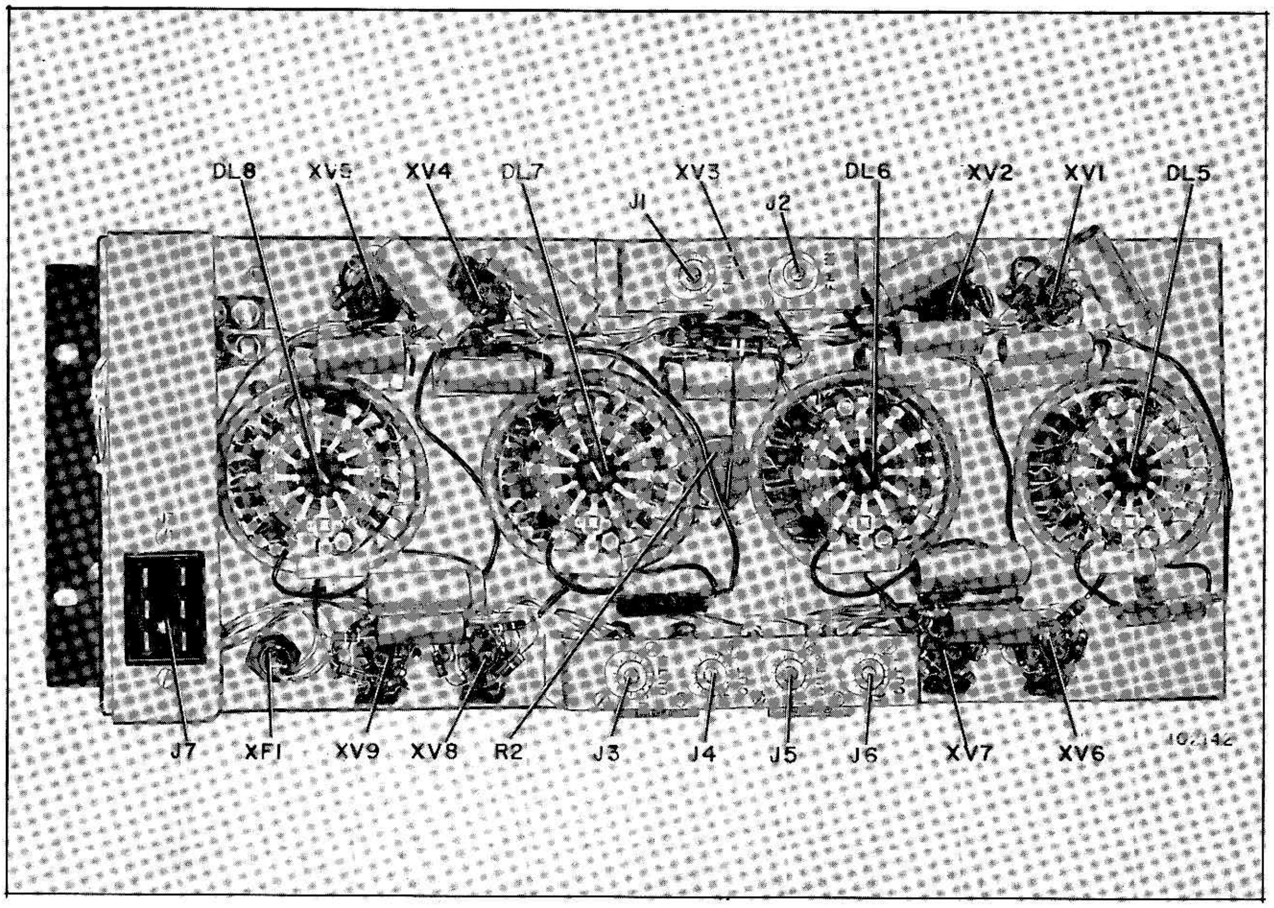


Figure RDA-6. Record Delay Amplifier, Component Identification

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
RECORD DELAY AMPLIFIER (8974488-502)			7
			CAPACITORS:
C1		8811182-5	ceramic, 0.01 μf +100 -20%, 450 v
C2		735715-175	paper, 0.1 μf ±10%, 400 v
C3		8811182-5	ceramic, 0.01 μf +100 -20%, 450 v
C4 to C10		735715-175	paper, 0.1 μf ±10%, 400 v
C11 to C31			Not Used
C32		735715-175	paper, 0.1 μf ±10%, 400 v
C33			Not Used
C34		735715-175	paper, 0.1 μf ±10%, 400 v
C35			Not Used
C36		735715-175	paper, 0.1 μf ±10%, 400 v
C37			Not Used
C38,C39		735715-175	paper, 0.1 μf ±10%, 400 v
C40		735715-163	paper, 0.01 μf ±10%, 400 v
C41		735715-175	paper, 0.1 μf ±10%, 400 v
C42		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C43		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C44		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C45		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C46		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C47		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C48		727853-229	mica, 180 μμf ±5%, 500 v char "D"
C49		727853-228	mica, 160 μμf ±5%, 500 v char "D"
C50 to C53			Not Used
C54 to C57		727853-240	mica, 510 μμf ±5%, 300 v char "D"
DL1 to DL4			Not Used
DL5 to DL8	219886	8979723-502	Delay Line
	215974	727853-335	Capacitor - mica, 330 μμf ±2%, 500 v, C1 to C20 (Pt. of DL5 to DL8)
DS1	101857	872291-9	Lamp: neon
F1	212327	990157-106	Fuse: ½ amp
J1 to J6	51800	255223-2	Connector: coax
J7	51604	727969-3	Connector: male, 6 contact, chassis mtg.
P1			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adapter, solder type
P2	210715	8909771-501	Connector termination
P3 to P6			Connector: coax, cable mtg.
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P7	51607	727969-4	Connector: female, 6 contact, cable mtg.
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-74	10,000 ohm ±10%, ½ w
R2	95245	8971860-4	variable, 250 ohm ±10%, 2 w
R3		82283-54	220 ohm ±10%, ½ w
R4		99126-74	10,000 ohm ±10%, 2 w
R5			Not Used
R6		82283-74	10,000 ohm ±10%, ½ w
R7	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R8 to R11			Not Used
R12	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R13 to R15			Not Used
R16	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R17 to R19			Not Used
R20	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R21 to R49			Not Used
R50		82283-46	47 ohm ±10%, ½ w
R51			Not Used
R52	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R53,R54		82283-46	47 ohm ±10%, ½ w
R55			Not Used
R56	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w

Symbol No.	Stock No.	Drawing No.	Description
R57, R58		82283-46	47 ohm ±10%, ½ w
R60	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R61, R62		82283-46	47 ohm ±10%, ½ w
R63			Not Used
R64	211616	458572-76	wire wound, 9000 ohm ±5%, 5 w
R65		82283-46	47 ohm ±10%, ½ w
R66		82283-111	10 ohm ±5%, ½ w
R67			Pt. of XDS1
R68		82283-94	470,000 ohm ±10%, ½ w
R69, R70		82283-54	220 ohm, ±10%, ½ w
R71 to R74			Not Used
R75 to R78		82283-134	91 ohm ±5%, ½ w
R79	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R80	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R81	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R82	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R83	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R84	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R85	219960	990730-166	film, 47.5 ohm ±1%, ½ w
R86	219961	990730-167	film, 48.7 ohm ±1%, ½ w
R87 to R94		82283-54	220 ohm ±10%, ½ w
T1	57021	949069-1	Transformer
TP1			Not Used
TP2 to TP6	208983	8825493-7	Jack
XADS1	208080	990788-507	Jewel
XDS1	208458	990789-5	Socket: lamp
XF1	48894	99088-2	Holder: fuse
XV1 to XV9	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	212940	8905470-1	Dial Plate
	99244	8849946-1	Knob: red
V1 to V9	219675		Tube: type #6922

VOLTAGE CHART — RECORD DELAY AMPLIFIER

NOTES: 1. Voltage measurements made with Voltohmyst.
2. Machine in SETUP mode of operation.
3. AC line voltage — 117 volts.
4. All voltages dc except where indicated.

Tube Symbol	Tube Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V1	6922	105	0	1.8	6.3 ac	0	105	0	1.8	0
V2	6922	105	0	1.8	6.3 ac	0	105	0	1.8	0
V3	6922	150	2.8	6.0	6.3 ac	0	150	2.8	6.0	0
V4	6922	105	0	1.8	6.3 ac	0	105	0	1.8	0
V5	6922	105	0	1.8	6.3 ac	0	105	0	1.8	0
V6	6922	80	.9	2.0	6.3 ac	0	80	.9	2.0	0
V7	6922	80	.9	2.0	6.3 ac	0	80	.9	2.0	0
V8	6922	80	.9	2.0	6.3 ac	0	80	.9	2.0	0
V9	6922	80	.9	2.0	6.3 ac	0	80	.9	2.0	0

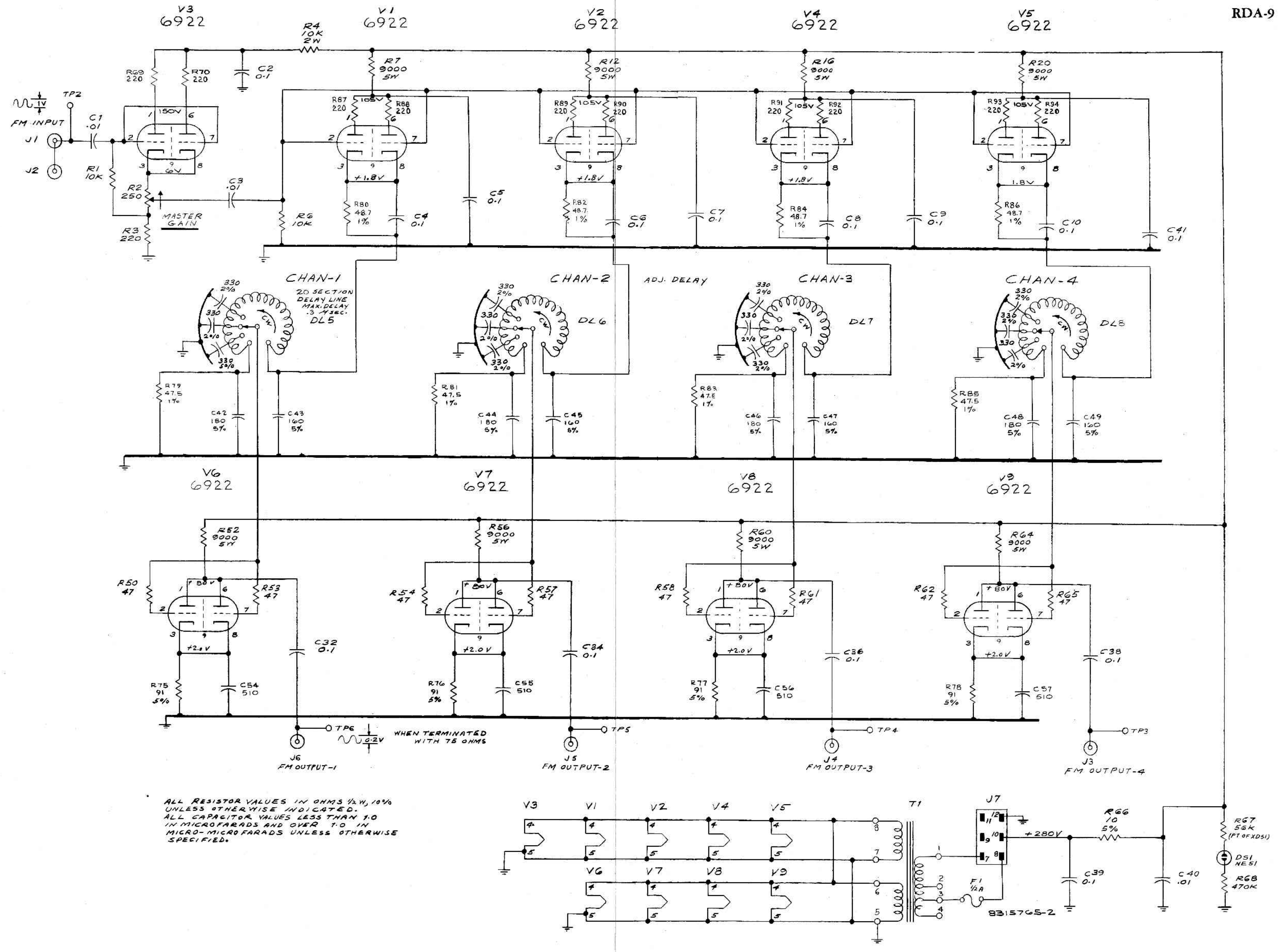


Figure RDA-7. Schematic Diagram and Voltage Chart Record Delay Amplifier

Playback Amplifier

UNIT 109

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

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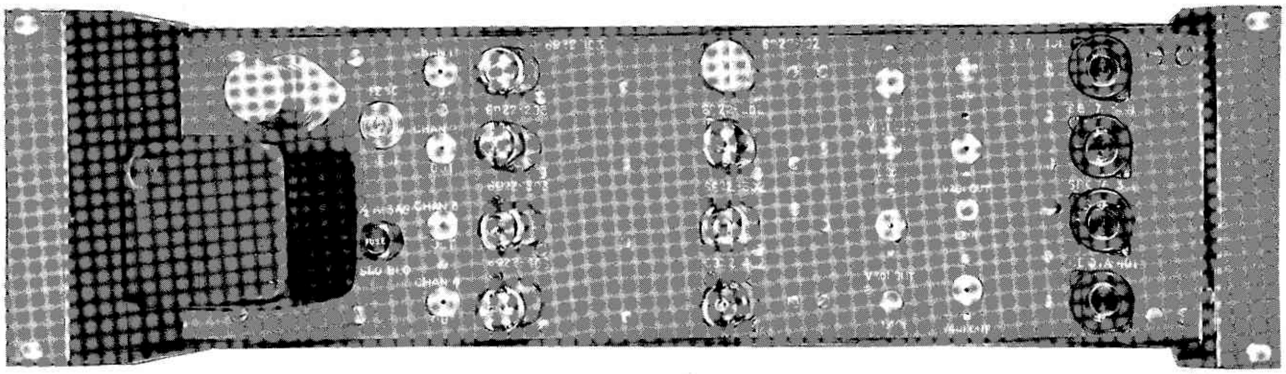

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Figure VPA-1. Playback Amplifier, Front View

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles, 40 watts (from circuit breaker No. 1)

DC: 280 volts, 200 ma (from power supply No. 1, unit 409)

Inputs

Four fm signals (from video preamplifier, unit 203)

Frequency Response

Flat from 1 to 10 megacycles (in conjunction with video preamplifier)

Gain

48 ±3 db per channel, fixed (in conjunction with video preamplifier)

Output Load Impedance

160 ohms

Outputs

Four amplified fm signals: 1 volt peak-to-peak, nominal (to playback delay amplifier, unit 106)

Fuse

½ ampere, slo-blo, 3AG

Tube Complement

8 — 6922
4 — 6BQ7A

DESCRIPTION

The playback amplifier (unit 109), shown in Figure VPA-1, is a four-channel amplifier used to provide a 48 db gain for the video head voltages received from the video preamplifier (unit 203) during the PLAY mode of operation. The amplified output signals are fed to the playback delay amplifier (unit 106). During the RECORD mode, the unit is not used and B+ voltage is removed from the chassis.

Circuit

The playback amplifier consists of four independent channels, each receiving an input signal from the first half of an individual cascode stage on the video preamplifier chassis during the PLAY mode.

As shown on the schematic diagram, Figure VPA-4, the input signal to channel one of the playback amplifier is fed to input jack J101 and appears at the cathodes of the second half of the cascode stage (V101). The output of V101 may be observed at test point TP101 (V101 OUT).

A variable inductor (L101), in the plate circuit of V101, allows some adjustment of the frequency response curve. The primary purpose of this adjustment is to obtain frequency response curves from each channel which are approximately flat from 1 to 10 megacycles while remaining as nearly identical to each other as possible. (To adjust the inductor, see *Maintenance.*)

Following amplification by V101, the signal is further amplified by three successive stages of voltage amplification (V102A, V102B, and V103). The output signal appears at jack J102 and is fed into a 160-ohm line to the playback delay amplifier. Test point TP102 (CHAN 1 OUT) is provided for convenience in observing the output of channel one.

The operation of the three remaining channels is identical to that of channel one.

In the PLAY mode of operation, the playback amplifier and video preamplifier provide a fixed gain of 48 ±3 db per channel. The frequency response of each channel is essentially flat from 1 to 10 megacycles, with a slight rising characteristic which peaks in the vicinity of 7 megacycles and then gradually tapers off.

In the RECORD mode, the unit is not used and does not receive B+ voltage. The NE-51 neon bulb on the chassis front panel indicates the application of B+ voltage to the chassis and therefore is extinguished during the RECORD mode.

MAINTENANCE

Frequency Response and Gain

A procedure for adjusting the frequency response and checking the gain of the unit is outlined below. A list of test equipment required consists of the following:

1. Video sweep generator (0 to 10 mc sweep).

2. Wide-band oscilloscope (Tektronix Type 535 or equivalent).

3. Low-capacity oscilloscope probe.

4. Calibrated rf attenuator.

5. Test connector (RCA stock No. 205330; Amphenol No. 26-151).

To adjust the frequency response and check the gain of the unit, proceed as follows:

1. Remove headwheel panel from the machine and plug test connector into the video preamplifier connector (J3).

2. Adjust rf attenuator for 48 db attenuation and connect it to the sweep generator.

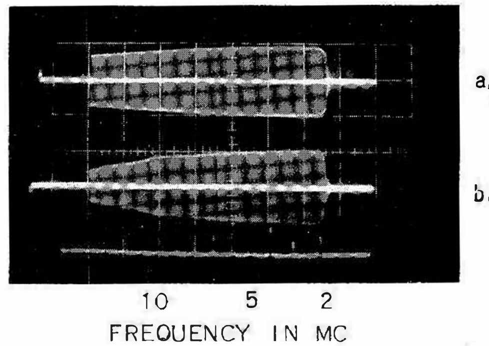
3. Connect coax cable from attenuator to test connector, using short clips on the end of the cable. Ground cable to metal case of the preamplifier and clip center conductor of the cable to the test connector pin corresponding to the channel to be swept:

Channel 1	pin 11
Channel 2	pin 5
Channel 3	pin 10
Channel 4	pin 2

4. Adjust sweep generator output to one volt peak-to-peak.

5. Connect low-capacity oscilloscope probe to output test point (TP102, etc.) of the channel being swept and observe the output signal.

6. Adjust the variable inductor (L101, etc.) so that the frequency response of the output signal is approximately flat from 1 to 10 mc, while remaining as nearly identical to the response curves of the other channels as possible. At 1 mc, the output voltage amplitude should equal the input voltage amplitude (1 volt peak-to-peak) within 3 db. (Refer to Figure VPA-2.)



a. Input Test Point (TP101, etc.)
b. Output Test Point (TP102, etc.)

Figure VPA-2. Typical Frequency Response Curves (Sweep Input)

7. Repeat the above procedure for each of the remaining channels.

Trouble Shooting

Loss of fm gain and noise in the picture may be symptoms of troubles in the playback amplifier. These troubles are usually caused by weak or defective tubes; therefore check all tubes as the first step in trouble shooting the unit.

If poor frequency response cannot be corrected by replacing tubes, check the lead dress of resistors R107, R111 and capacitor C109. (Similarly in channels 2, 3, and 4.) This is especially important if these components have been replaced.

Voltage Readings

The *Voltage Table* indicates typical tube-socket voltages with respect to ground, obtained with a vacuum-tube voltmeter. All voltages are dc unless otherwise noted.

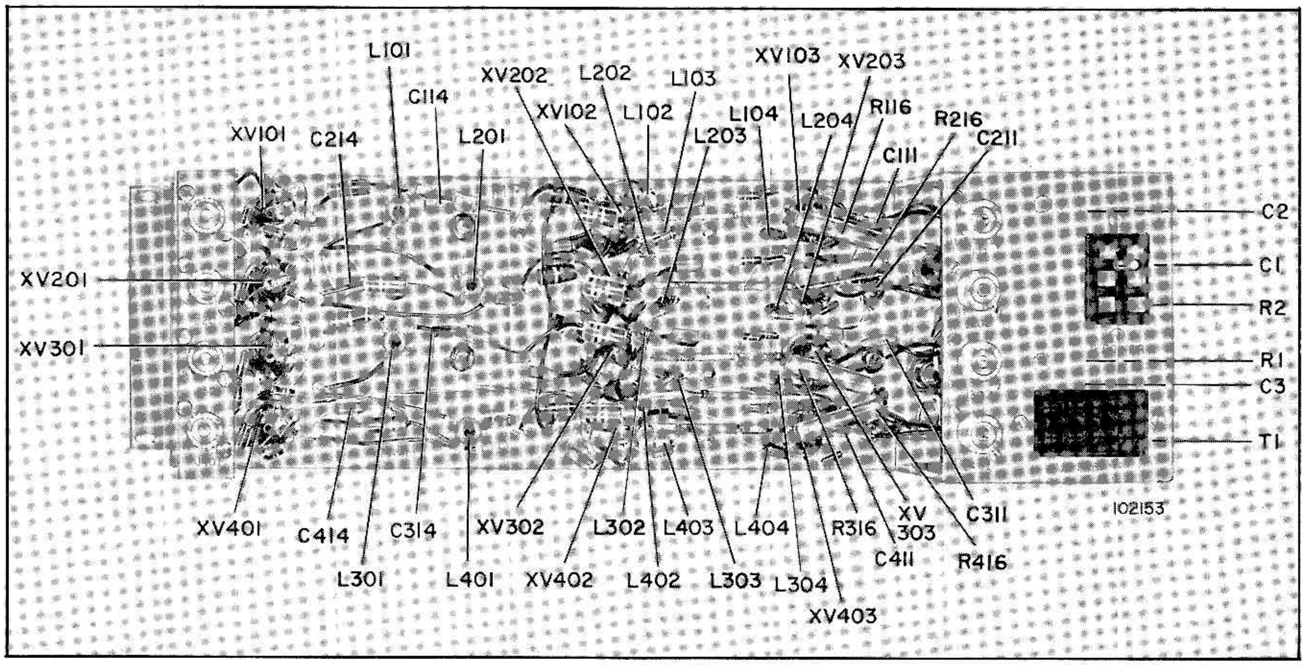


Figure VPA-3. Rear View of Playback Amplifier

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			PLAYBACK AMPLIFIER (8974417-503) 6
			CAPACITORS:
C1A, B	99295	458557-14	electrolytic, 10/10 μf -10 +50%, 450 v
C2		735715-133	paper, 0.47 μf ±20%, 400 v
C3		735715-251	paper, 0.001 μf ±10%, 600 v
C4 to C103			Not Used
C104	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C105		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C106		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C107		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C108		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C109		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C110			Not Used
C111	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C112AB, C113AB	218128	8971848-10	ceramic, 0.005/0.005 μf +80 -20%, 150 v
C114		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C115 to C203			Not Used
C204	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C205		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C206		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C207		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C208		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C209		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C210			Not Used
C211	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C212AB, C213AB	218128	8971848-10	ceramic, 0.005/0.005 μf +80 -20%, 500 v
C214		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C215 to C303			Not Used
C304	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C305		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C306		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"

Symbol No.	Stock No.	Drawing No.	Description
C307		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C308		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C309		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C310			Not Used
C311	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C312AB, C313AB	218128	8971848-10	ceramic, 0.005/0.005 μf +80 -20%, 500 v
C314		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C315 to C403			Not Used
C404	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C405		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C406		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C407		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C408		727853-231	mica, 220 $\mu\mu$f ±5%, 500 v char "D"
C409		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
C410			Not Used
C411	218127	8976580-2	ceramic, 0.05 μf +80 -20%, 500 v
C412AB, C413AB	218128	8971848-10	ceramic, 0.005/0.005 μf +80 -20%, 150 v
C414		727853-239	mica, 470 $\mu\mu$f ±5%, 300 v char "D"
DS1	101857	872291-9	Lamp: neon NE51
F1	212327	990157-106	Fuse: ½ amp, slo-blo
J1	51604	727969-3	Connector: male, 6 contact, chassis mtg.
J2	56077	727969-5	Connector: female, 8 contact, chassis mtg.
J3 to J100			Not Used
J101, J102	51800	255223-2	Connector: coax, chassis mtg.
J103 to J200			Not Used
J201, J202	51800	255223-2	Connector: coax, chassis mtg.
J203 to J300			Not Used
J301, J302	51800	255223-2	Connector: coax, chassis mtg.
J303 to J400			Not Used
J401, J402	51800	255223-2	Connector: coax, chassis mtg.
L101	213197	476933-3	Coil: variable, 5/9 microhenry
L102	99792	8825473-506	Coil: R.F. choke, 15 microhenry
L103	202910	8825473-505	Coil: R.F. choke, 10 microhenry
L104	99791	8825473-504	Coil: R.F. choke, 8 microhenry
L105 to L200			Not Used
L201	213197	476933-3	Coil: variable, 5/9 microhenry
L202	99792	8825473-506	Coil: R.F. choke, 15 microhenry
L203	202910	8825473-505	Coil: R.F. choke, 10 microhenry
L204	99791	8825473-504	Coil: R.F. choke, 8 microhenry
L205 to L300			Not Used
L301	213197	476933-3	Coil: variable, 5/9 microhenry
L302	99792	8825473-506	Coil: R.F. choke, 15 microhenry
L303	202910	8825473-505	Coil: R.F. choke, 10 microhenry
L304	99791	8825473-504	Coil: R.F. choke, 8 microhenry
L305 to L400			Not Used
L401	213197	476933-3	Coil: variable, 5/9 microhenry
L402	99792	8825473-506	Coil: R.F. choke, 15 microhenry
L403	202910	8825473-505	Coil: R.F. choke, 10 microhenry
L404	99791	8825473-504	Coil: R.F. choke, 8 microhenry
P1	51607	727969-4	Connector: female, 6 contact
P2	58978	727969-6	Connector: male, 8 contact, cable mtg.
P3 to P100			Not Used
P101			Connector: coax
	215661	252868-1	Connector only
	54246	893648-2	Adapter, solder type
P102			Connector: coax
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P103 to P200			Not Used
P201			Connector: coax
	215661	252868-1	Connector only
	54246	893648-2	Adapter, solder type

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
P202			Connector: coax
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P203 to P300			Not Used
P301			Connector: coax
	215661	252868-1	Connector only
	54246	893648-2	Adapter, solder type
P302			Connector: coax
	215661	252868-1	Connector only
		8979037-1	Adapter only
		8979036-3	Sleeve only
P303 to P400			Not Used
P401			Connector: coax
	215661	252868-1	Connector only
	54246	893648-2	Adapter, solder type
P402			Connector: coax
	215661	252868-1	Connector only
		8979037-1	Adpater only
		8979036-3	Sleeve only
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		99126-132	75 ohm ±5%, 2 w
R2	58060	8817665-7	wire wound, 250 ohm ±10%, 25 w
R3			Pt. of XDS1
R4		82283-94	470,000 ohm ±10%, ½ w
R5 to R101			Not Used
R102		82283-135	100 ohm ±5%, ½ w
R103		99126-161	1200 ohm ±5%, 2 w
R104		82283-207	100,000 ohm ±5%, ½ w
R105		82283-135	100 ohm ±5%, ½ w
R106		82283-207	100,000 ohm ±5%, ½ w
R107		82283-161	1200 ohm ±5%, ½ w
R108		99126-191	22,000 ohm ±5%, 2 w
R109		82283-137	120 ohm ±5%, ½ w
R110		82283-161	1200 ohm ±5%, ½ w
R111		99126-191	22,000 ohm ±5%, 2 w
R112		82283-137	120 ohm ±5%, ½ w
R113, R114		82283-135	100 ohm ±5%, ½ w
R115		82283-162	1300 ohm ±5%, ½ w
R116	213112	942989-149	10,000 ohm ±5%, 4 w
R117		82283-137	120 ohm ±5%, ½ w
R118		82283-183	10,000 ohm ±5%, ½ w
R119 to R201			Not Used
R202		82283-135	100 ohm ±5%, ½ w
R203		99126-161	1200 ohm ±5%, 2 w
R204		82283-207	100,000 ohm ±5%, ½ w
R205		82283-135	100 ohm ±5%, ½ w
R206		82283-207	100,000 ohm ±5%, ½ w
R207		82283-161	1200 ohm ±5%, ½ w
R208		99126-191	22,000 ohm ±5%, 2 w
R209		82283-137	120 ohm ±5%, ½ w
R210		82283-161	1200 ohm ±5%, ½ w
R211		99126-191	22,000 ohm ±5%, 2 w
R212		82283-137	120 ohm ±5%, ½ w
R213, R214		82283-135	100 ohm ±5%, ½ w
R215		82283-162	1300 ohm ±5%, ½ w
R216	213112	942989-149	10,000 ohm ±5%, 4 w
R217		82283-137	120 ohm ±5%, ½ w
R218		82283-183	10,000 ohm ±5%, ½ w
R219 to R301			Not Used
R302		82283-135	100 ohm ±5%, ½ w
R303		99126-161	1200 ohm ±5%, 2 w
R304		82283-207	100,000 ohm ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R305		82283-135	100 ohm ±5%, ½ w
R306		82283-207	100,000 ohm ±5%, ½ w
R307		82283-161	1200 ohm ±5%, ½ w
R308		99126-191	22,000 ohm ±5%, 2 w
R309		82283-137	120 ohm ±5%, ½ w
R310		82283-161	1200 ohm ±5%, ½ w
R311		99126-191	22,000 ohm ±5%, 2 w
R312		82283-137	120 ohm ±5%, ½ w
R313, R314		82283-135	100 ohm ±5%, ½ w
R315		82283-162	1300 ohm ±5%, ½ w
R316	213112	942989-149	10,000 ohm ±5%, 4 w
R317		82283-137	120 ohm ±5%, ½ w
R318		82283-183	10,000 ohm ±5%, ½ w
R319 to R401			Not Used
R402		82283-135	100 ohm ±5%, ½ w
R403		99126-161	1200 ohm ±5%, 2 w
R404		82283-207	100,000 ohm ±5%, ½ w
R405		82283-135	100 ohm ±5%, ½ w
R406		82283-207	100,000 ohm ±5%, ½ w
R407		82283-161	1200 ohm ±5%, ½ w
R408		99126-191	22,000 ohm ±5%, 2 w
R409		82283-137	120 ohm ±5%, ½ w
R410		82283-161	1200 ohm ±5%, ½ w
R411		99126-191	22,000 ohm ±5%, 2 w
R412		82283-137	120 ohm ±5%, ½ w
R413, R414		82283-135	100 ohm ±5%, ½ w
R415		82283-162	1300 ohm ±5%, ½ w
R416	213112	942989-149	10,000 ohm ±5%, 4 w
R417		82283-137	120 ohm ±5%, ½ w
R418		82283-183	10,000 ohm ±5%, ½ w
T1	58619	895326-4	Transformer: filament
TP101, TP102	208983	8825493-7	Jack: tip yellow
TP103 to TP200			Not Used
TP201, TP202	208983	8825493-7	Jack: tip yellow
TP203 to TP300			Not Used
TP301, TP302	208983	8825493-7	Jack: tip yellow
TP303 to TP400			Not Used
TP401, TP402	208983	8825493-7	Jack: tip yellow
XADS1	208080	990788-507	Jewel
XDS1	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XV101 to XV103	94926	737870-14	Socket: tube, 9 pin
XV104 to XV200			Not Used
XV201 to XV203	94926	737870-14	Socket: tube, 9 pin
XV204 to XV300			Not Used
XV301 to XV303	94926	737870-14	Socket: tube, 9 pin
XV304 to XV400			Not Used
XV401 to XV403	94926	737870-14	Socket: tube, 9 pin
V102, V103, V202 V203, V302, V303 V402, V403	219675		Tube: type #6922

VOLTAGE TABLE

Tube Symbol	*Tube Type*	*Pin Number* 1	2	3	4	5	6	7	8	9
V101, V201 V301, V401	6BQ7A	200	104	105	6.3 ac	Gnd	200	104	105	Gnd
V102, V202 V302, V402	6922	60	0	0.9	6.3 ac	Gnd	60	0	0.9	Gnd
V103, V203 V303, V403	6922	85	0	1.5	6.3 ac	Gnd	85	0	1.5	Gnd

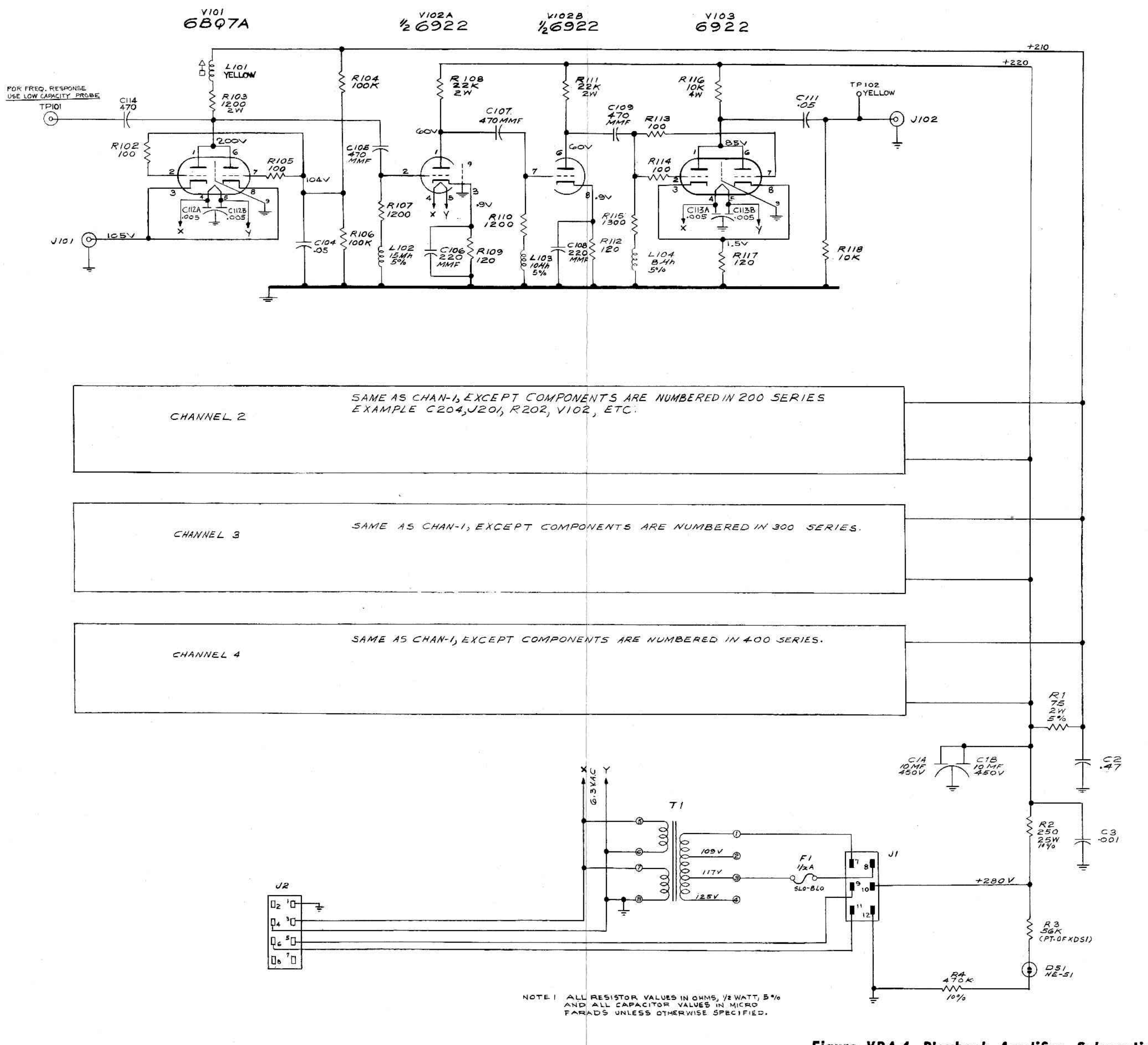


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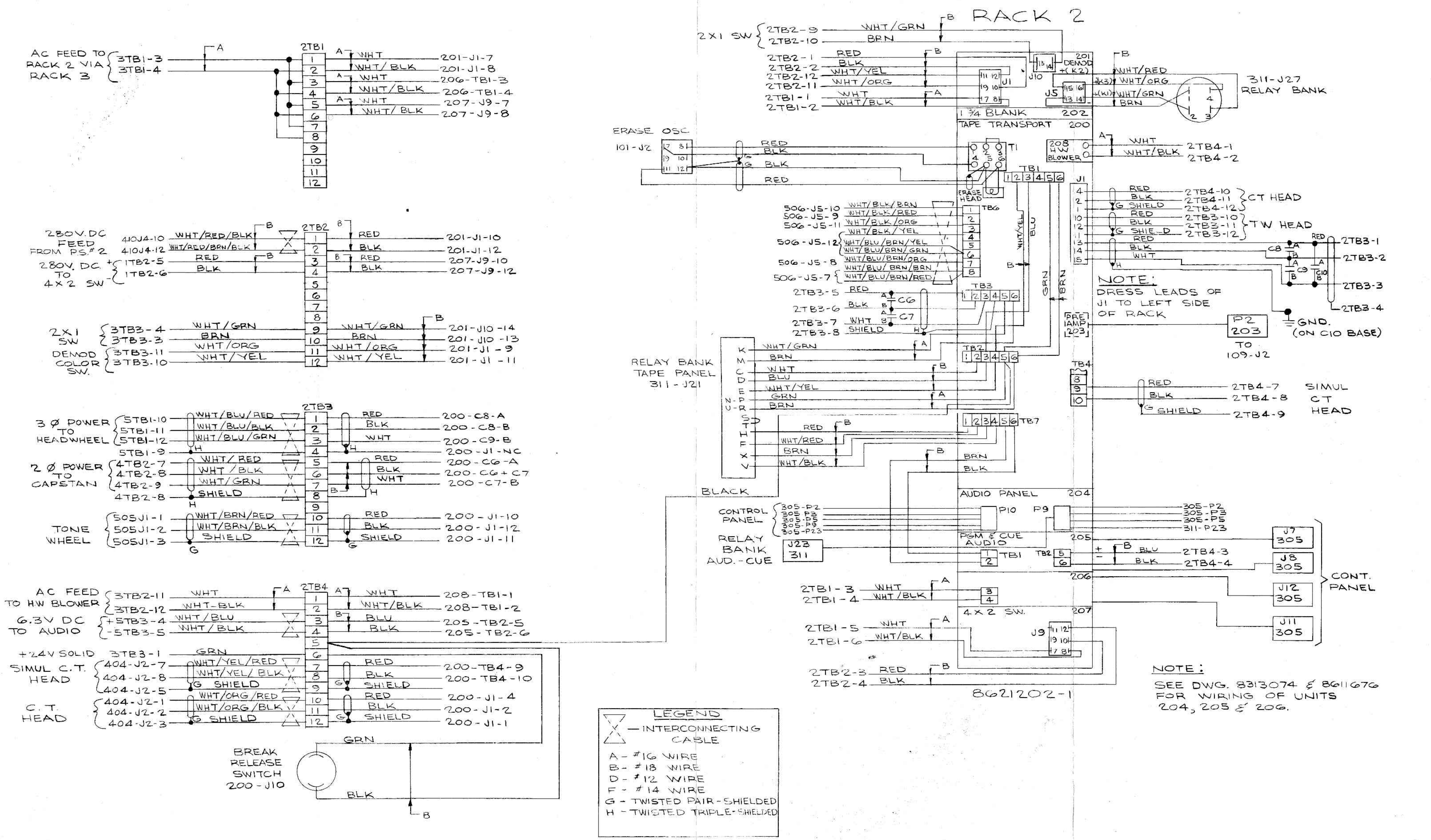
Figure VPA-4. Playback Amplifier, Schematic Diagram

PARTS LIST

Symbol No.	Stock No.	Drawing No.	Description
			RACK #2 (8975562-503) 11
			Miscellaneous:
205-C6	213595	737818-12	Capacitor: paper, 0.068 μf ±10%, 100 v
205-C7, C8		8811182-5	Capacitor: ceramic, 10,000 $\mu\mu f$ -20 +100%, 450 v
206-C7	209759	737818-13	Capacitor: paper, 0.1 μf ±10%, 100 v
205A/H-J1, 206A/C-J1, 206B-J2	205331	459623-1	Connector: female, 15 contact, chassis mtg.
205-R1	209834	458592-6	Resistor: fixed, wire wound, 20 ohm ±10%, 5 w
205-R2		458592-3	Resistor: fixed, wire wound, 5 ohm ±10%, 5 w
205-R3	209834	458592-6	Resistor: fixed, wire wound, 20 ohm ±10%, 5 w
205-R4, R5	57221	458575-109	Resistor: var. 5000 ohms ±10%, 2 w
2TB1, 2TB2		449691-5	Board: terminal
205-TB3, TB4		99153-31	Board: terminal
205-TB1, TB2, 206-TB1-TB2		8441358-6	Board: terminal
	222578	8979050-2	Hose: air headwheel blower to headwheel panel
	94426	897258-2	Clamp: air hose above



Interconnection Diagram, Rack 2

Demodulator

UNIT 201

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31140

PRINTED IN U.S.A.
DU 651

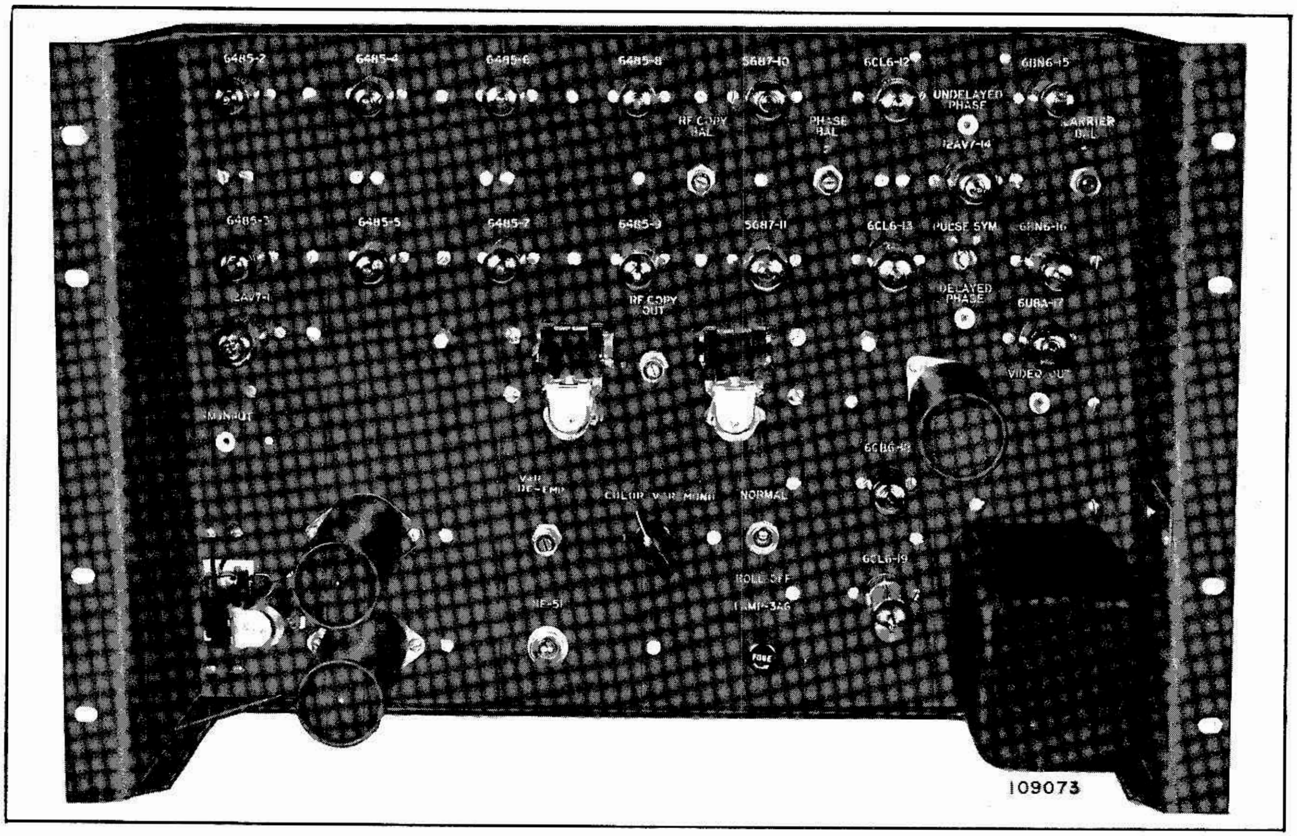


Figure DEM-1. Demodulator, Front View

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles, 63 watts
(from circuit breaker No. 2)

DC: 280 volts, 310 ma
(from power supply No. 2, unit 410)

Inputs

FM signal from 2X1 switcher, unit 309
(in PLAY mode)

FM signal from modulator, unit 102
(in SETUP or RECORD mode)

RF copy from demodulator of machine No. 2
(when used to record rf copies from a second machine)

Input Levels

Demodulator: 1 volt peak-to-peak (fm)

RF Copy: 1 ±.2 volt peak-to-peak (fm)

Input Impedances

75 ohms at J2 (2X1 switcher input)

High impedance bridging at J6 and J8
(modulator and rf copy inputs)

Limiting

50 db minimum (below 1 volt)

De-emphasis

Monochrome: 4.0 db, nominal, at 4 mc

Color: 9.54 db, nominal, at 4 mc

Variable: Approximately 2 db to 12 db at 4 mc

Outputs

Video signal to distribution amplifier No. 2
(unit 303)

RF copy to demodulator of machine No. 2
(when used to originate rf copies for a second machine)

Output Levels

Demodulator: 1 volt peak-to-peak, nominal
(composite video)

RF Copy: 1 volt peak-to-peak, nominal (fm)

Output Impedance

75 ohms

Fuse

1 ampere, 250 volt, slo-blo, 3AG

Tube and Diode Complement

Tubes: 2 — 12AV7
8 — 6485
3 — 6CL6
2 — 5687
2 — 6BN6
1 — 6U8
1 — 6CB6

Diodes: 6 — 1N270

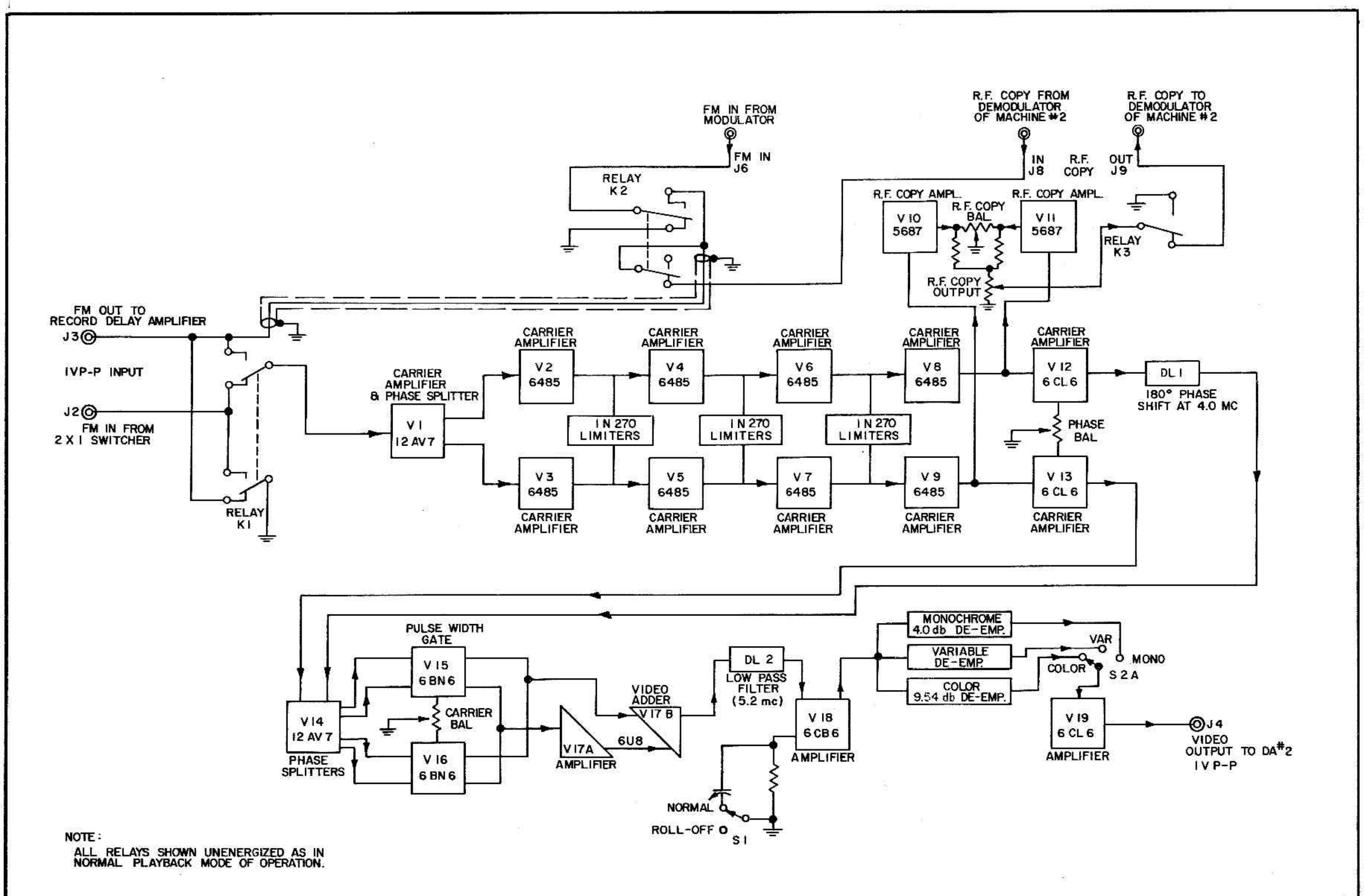


Figure DEM-2. Demodulator Block Diagram

DESCRIPTION

The demodulator (unit 201) is shown in figure DEM-1. The basic purpose of the unit is to detect the video information contained in a frequency modulated input signal. As shown on the block diagram, figure DEM-2, the input fm signal from one of three different sources is selected by appropriate relays according to the desired tape recorder mode of operation. The sources of fm input signals are the 2X1 switcher (PLAY mode), modulator (RECORD mode), and rf copy output from the demodulator of a second machine (RF COPY-RECORD).

The rf copy circuit provides a means of producing copies of pre-recorded video tapes by recording on one machine *(slave)* the fm information received from tapes played back on another machine *(master)*.

Controls

As shown in figure DEM-1, controls on the demodulator front panel consist of the following:

Three position de-emphasis switch (COLOR-VAR-MONO)
Bandwidth toggle switch (NORMAL/ROLL-OFF)
Phase balance control (PHASE BAL)
Carrier balance control (CARRIER BAL)
Variable de-emphasis control (VAR DE-EMP)
RF copy balance control (RF COPY BAL)
RF copy output control (RF COPY OUT)

Principle of Operation

The demodulator performs essentially the same functions as the conventional ratio detector or limiter-discriminator stages in fm broadcast receivers, which consist of amplification, limiting, and the production of an output voltage which exactly follows the amplitude variations of the original modulating signal. However, because exact reproduction of a video signal requires strict linearity in both amplitude and phase over a wide frequency range, the technique is different.

To obtain the desired linearity the demodulator utilizes the principle that if a signal is passed through a delay line having a fixed time delay for all frequencies under consideration, the phase angle between the input and output of the line is directly proportional to frequency. If the delayed and undelayed signals are then applied to two grids of a 6BN6 "pulse width gate" (described under *Circuit*), the output of the gate consists of a train of positive rectangular pulses whose duty cycle (ratio of "ON" time to total time of a cycle) depends in a linear manner on the phase angle between the two signals.

The average value or dc component of each cycle in the train of pulses is proportional to its duty cycle. Thus, over a number of cycles, the average value varies in a linear manner with respect to the input signal frequency. If the pulses are then fed through a low-pass filter which eliminates all frequencies above the video band, an output voltage will be obtained having an amplitude proportional to the input signal frequency. The output voltage will then be a replica of the video signal used to modulate the carrier.

The actual demodulator is more complicated than the preceding may seem to indicate because the outputs of two gate circuits, differing in phase by 180°, are added together. This effectively cancels the fundamental frequency component of the gated pulses and retains the double frequency component. The undesired pulses are then easily filtered from the video output voltage.

The pulse width gates operate most effectively when the grid signals are square waves. Therefore a minimum of 50 db limiting of the 1 volt input signal is provided to guarantee a fast rise-time signal on these grids. The high limiting also minimizes the effect of tape dropouts and other forms of amplitude modulation.

An fm output signal for use in making rf copies of tapes is also provided by the demodulator. RF copying differs from the video-to-video method of reproducing tapes in that the fm information is used in making copies instead of the demodulated playback signal. A slight improvement in frequency response and signal-to-noise ratio may be achieved by this method. However, care must be taken to insure that all equipment used in making rf copies (such as distribution amplifiers or switchers for making several copies simultaneously) have good phase and frequency response to 10 megacycles to prevent possible excessive signal degradation.

In making rf copies, fm information from the tape in the master machine is processed through the normal playback system to the demodulator. In the demodulator the fm information is fed to the rf copy circuit after appropriate limiting. The rf copy circuit combines the two signals derived from the balanced rf stages of the demodulator into a single-ended 75 ohm output. The output signal is then fed to the rf copy input of the slave machine.

Circuit

The frequency modulated input signal to the demodulator is obtained from the modulator, 2X1 switcher, or rf copy output of the demodulator of a second machine, depending upon the tape recorder

RELAY OPERATION TABLE

Recorder Mode of Operation	*Control Panel Switch Pressed*	*Relay*		
		K1	*K2*	*K3*
Normal Record	RECORD or SETUP	E	E	D
Normal Play or Stop	PLAY or STOP	D	D	D
RF Play (sending)	RF COPY and PLAY	D	D	E
RF Record (receiving)	RF COPY and RECORD	E	D	D
RF Setup (sending) (For setup between 2 machines)	RF COPY and SETUP	E	E	E
RF Only (receiving) (For setup between 2 machines)	RF COPY	E	D	D

E Energized. D De-energized.

mode of operation. The *Relay Operation Table* shows the condition of each demodulator relay (K1, K2, and K3) when the specified pushbutton switch on the control panel (unit 305) is pressed for the various modes of operation.

The input from the 2X1 switcher is selected when K1 is de-energized. This occurs during the normal PLAY mode or when the machine is used as the master in making rf copies of a tape. In all other modes of operation K1 is energized and the input is selected by K2. The input from the modulator is selected when K2 is energized, as in normal RECORD or SETUP modes or RF SETUP when the machine is used as the master in setting up two machines for making rf copies. The input from the rf copy output of a second machine is selected when K2 is de-energized. This occurs when the machine is used as the slave in making rf copies or in setting up to make rf copies. Relay K3 is energized when the machine is used as the master, thus connecting the rf copy output to jack J9 from which it is fed to the slave machine.

The input signals are fed to jacks J2, J6, and J8 as shown on the schematic diagram, figure DEM-14, and may be observed at test point TP1 (figure DEM-3). The incoming signal from the modulator or the rf copy output of a second machine is looped from J6 to J3, from which it is fed to the record delay amplifier and terminated.

Tube V1A acts as a straightforward fm amplifier, with the required frequency response being obtained by coil L1 in its plate circuit. The amplified fm signal is coupled to the control grid of V1B which operates as a phase splitter. The fm signals, with amplitudes of approximately 4.5 volts peak-to-peak, are taken off the plate and cathode of V1B and fed to push-pull amplifiers V2 and V3, 180° out of phase. The circuitry is designed so that the amplifiers have series regulating action, resulting in plate current flow of equal magnitude in each tube.

Diodes CR1 and CR2 in the plate circuits of carrier amplifiers V2 and V3 provide symmetrical limiting of the fm signal. The diodes are alternately conducting and non-conducting, depending upon the bias voltage applied. The amount of bias on each diode is determined by the magnitude of the voltage drop across resistors R25 and R28. Coils L2 and L3, also in the plate circuits of V2 and V3, are utilized as series peaking coils.

Two additional stages of amplification and limiting follow, whose operations are identical to that described above. These consist of push-pull amplifiers V4/V5, V6/V7 and diode limiters CR3/CR4, CR5/CR6. The clipped fm signal, having an amplitude of approximately 1.5 volts peak-to-peak, is applied to push-pull amplifiers V8/V9 and V12/V13 in turn. Because of component tolerances, some unbalance may exist in the fm signal. Potentiometer R50 (PHASE BAL), in the cathode circuit of V12/V13, is provided to counteract this unbalance and insure symmetry (see *Maintenance*).

Amplifiers V12 and V13 raise the fm signal level to 23 volts peak-to-peak. From the plate circuit of V13 the signal is fed directly to the control grid (pin 7) of phase splitter V14B, while the signal appearing in the plate circuit of V12 passes through delay line DL1 before being fed to the control grid (pin 2) of phase splitter V14A. Delay line DL1 shifts the signal phase 180° at 4.0 mc, thus enabling the signals which appear at the control grids of V14 to be in phase at that frequency.

Each section of V14 splits the signal into two polarities before it is fed to a pair of matched 6BN6 tubes (V15, V16) comprising the pulse width gate. Looking

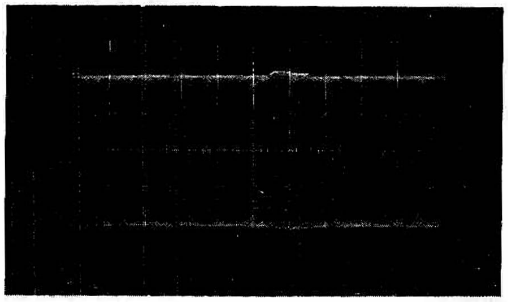


Figure DEM-3. Input Signal at TP1 (Machine in Setup)

at the right-hand section of V14, the signal appearing in its plate circuit is applied to the suppressor grid (pin 6) of pulse width gate tube V15, while the signal appearing in its cathode circuit is fed to the suppressor grid (pin 6) of pulse width gate tube V16. The signal appearing in the plate circuit of the left-hand section of V14 is fed to the control grid (pin 2) of V15, while the signal appearing in the cathode circuit is fed to the control grid (pin 2) of V16. Variable capacitor C54, in the cathode circuit of V14, may be adjusted to correct for wiring capacitance unbalance (see *Maintenance*). Test points TP2 (DELAYED PHASE) and TP3 (UNDELAYED PHASE) are provided for convenience in trouble shooting the unit.

The 6BN6 tubes (V15, V16) are pulse width gating tubes because of their ability to produce pulses of varying width and constant amplitude. The characteristics of these tubes are such that plate current will flow only during the time positive voltages appear at the control and suppressor grids simultaneously. Therefore, the width of the negative-going pulses appearing in the plate circuits of V15 and V16 is equal to the period of overlap of the positive pulses applied to the signal grids. This indicates that the widest negative plate pulse occurs when the signals are in phase and the narrowest when the signals are oppositely phased. It may also be noted that the dc component of the pulses is linearly related to the phase difference between the grid signals from 0 to 180°; 180° to 360°; etc. (with either a positive or negative slope). The net result of these characteristics is that the 6BN6 discriminator slopes are inherently linear-amplitude versus frequency.

Pulses appearing in the plate circuits of V15 and V16 do not occur simultaneously, but are uniformly interspaced in mid-positions because of the phase splitting action of V14. Thus, if the sets of pulses are well balanced, the combined gating output consists only of video information carried by even harmonics of the fm carrier.

A characteristic of the 6BN6 construction is that the sum of the plate and accelerator currents tends to remain constant and independent of both signal grid potentials. Therefore, a signal current in the plate circuit must be accompanied by a nearly equal signal current of opposite polarity in the accelerator circuit, thereby effectively providing a push-pull output from each gate. In addition to operation as pulse width gating tubes, V15 and V16 subject the fm signal to a large degree of limiting. Symmetrical limiting is obtained by the adjustment of potentiometer R107 (CARRIER BAL). (See *Maintenance*).

Signal information applied to video adder stage V17B is obtained from the plate and accelerator grid circuits of V15 and V16. The signal from the plate circuit is applied directly to grid number 1 (pin 2) of V17B while the signal from the accelerator grid circuit is inverted in V17A and coupled through common cathode resistor R122 to V17B. This information is added in V17B and applied to a 10-section low-pass filter (DL2) which removes the carrier harmonics and unbalanced fundamental carrier frequency above 5.0 megacycles. (In International machines, the cut-off frequency of this filter is 5.5 megacycles). When the deviation of the fm carrier does not occur below 5.2 megacycles, as in color operation, this filter adequately removes small unbalanced carrier components that would degrade the video signal. However, when deviation occurs down to 4.3 megacycles with blanking at 5.0 megacycles, as in monochrome operation, discriminator balance requires more careful adjustment to keep blanking free of residual carrier not removed by DL2.

The video signal from filter DL2 is fed into video amplifier V18. De-emphasis networks in the plate circuit of V18 are used to match the pre-emphasis developed in the modulator so that an improved signal-to-noise ratio will be obtained. Switch S2 (COLOR-VAR-MONO) selects the proper de-emphasis value: COLOR 9.54 db; MONO 4.0 db. Variable de-emphasis control R118 (VAR DE-EMP) provides a de-emphasis range of approximately 2 db to 12 db at 4.0 megacycles. This control, in conjunction with switch S2, is used to obtain the optimum de-emphasis value when playing back tapes recorded with other than the normal pre-emphasis values. The control is set by observing the oscilloscope (unit 306) with DEMOD OUT pushbutton pressed. Adjust the control to obtain minimum spikes (overshoots) on blanking or sync as described in *Setup for Operation.*

An additional function of switch S2, operating in series with the TEST-OPERATE switch on the burst oscillator (unit 605), is to open the line carrying 24

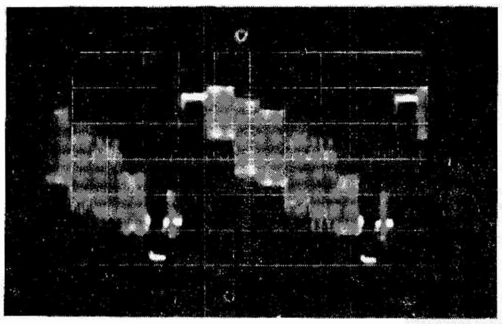


Figure DEM-4. Video Output Signal at TP4 (Machine in Setup)

volts dc to relay K2 on the chroma processor (unit 604) and relays 5K2 and K1 on the processing amplifier (unit 308) when in MONO or VAR position. When in COLOR position, with the burst oscillator switch in OPERATE position and burst add voltage applied to the automatic switcher, the 24 volt line is closed, thus energizing these relays.

NOTE: When recording monochrome information, switch S2 and its complementary switch on the modulator (CHROME-MONO) must be turned to MONO position. When recording color information, these switches must be placed in COLOR (or CHROME) position. The VAR position of S2 is never used during the RECORD mode. When playing back a tape, the modulator is out of the system; therefore it is not necessary to match the switches on both chassis during the PLAYBACK mode.

Variable capacitor C67, in the cathode circuit of V18, partially bypasses the cathode resistor to compensate for high frequency losses in the modulation and demodulation processes. While C67 is factory adjusted for flat frequency response (multiburst) with the machine in SETUP mode and should require no further adjustment, a procedure for making this adjustment is given in the section on *Maintenance* in the event the capacitor or related circuit components must be replaced. The capacitor may be switched out of the circuit by placing switch S1 (NORMAL/ROLL-OFF) in ROLL-OFF position if the bandwidth must be reduced to minimize objectionable noise in the picture. However, when S1 is placed in ROLL-OFF position signal resolution is lost with the noise.

Output stage V19 operates as a conventional video amplifier. The video output signal, having a nominal amplitude of one volt peak-to-peak, is taken off its cathode and fed to output jack J4. Test point TP4 (VIDEO OUT) is provided for convenience in monitoring the output video signal (figure DEM-4).

The discriminator slopes may be readily seen by applying a 1 volt peak-to-peak "sweep" signal to input jack J2 and observing the waveform at output jack J4. Figure DEM-5 indicates the ideal waveform (solid line) obtained with the demodulator well balanced and switch S2 in MONO position. The single-line slope from 4.0 to 8.0 megacycles is the discriminator slope used in demodulation. The large envelope at the left is the second harmonic which appears to be cut off at 2.5 megacycles but is actually cut off at 5.0 megacycles, the cutoff point of DL2.

RF Copy. The rf copy circuit consists of series amplifiers V10 and V11 interconnected so that individual inputs from carrier amplifiers V8 and V9 are combined into a single output. The output of each series amplifier is balanced by potentiometer R69 (RF COPY BAL). Potentiometer R75 (RF COPY OUT) is used to adjust the gain of the rf copy circuit without affecting the linearity of the processed information. The circuit is designed so that the frequency response of the amplifiers is flat from 1 megacycle to 10 megacycles ± 2 db when measured across a 75 ohm load. The processed rf copy information appears at output jack J9.

When producing rf copies it is necessary to connect RF COPY IN (J8) of machine No. 1 to RF COPY OUT (J9) of machine No. 2 and vice versa. Relays K2 and K3 determine the various operating modes of the unit and are actuated from the control panel (unit 305). The *Relay Operation Table* shows the condition of each relay during the recorder modes of operation.

SETUP FOR OPERATION

Place the COLOR-VAR-MONO switch in MONO position during monochrome operation of the tape recorder, and in COLOR position during color operation, to obtain the correct de-emphasis value. (The position of this switch must correspond to the position of its complementary switch on the modulator).

When playing back a tape having pre-emphasis other than the normal value, press pushbutton labeled DEMOD OUT on CRO/MON switcher (unit 307) and observe waveform on waveform monitor (unit 306). Place COLOR-VAR-MONO switch in VAR position and adjust VAR DE-EMP control to obtain minimum spikes (overshoots) on blanking or sync.

Place the NORMAL/ROLL-OFF switch in NORMAL position during all modes of operation of the tape recorder. Use the ROLL-OFF position only when the bandwidth must be reduced to minimize objectionable noise in the picture.

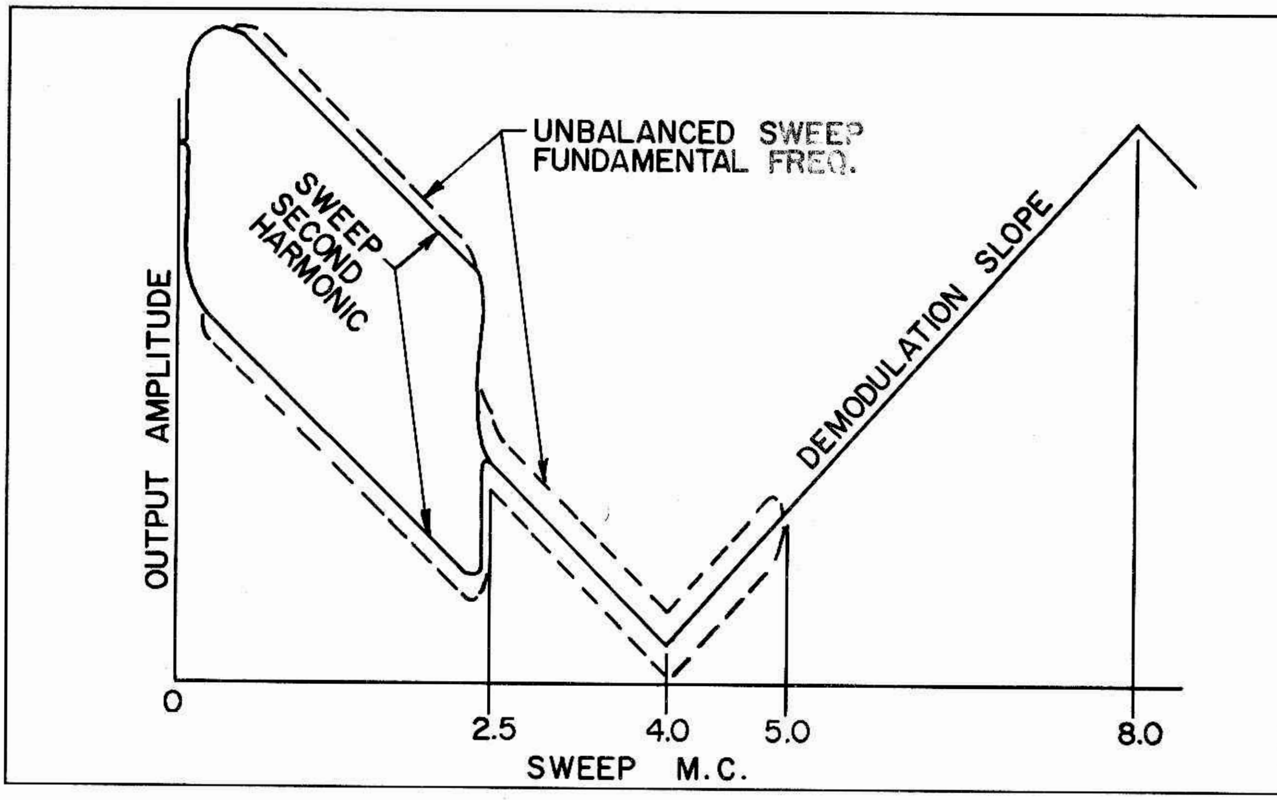


Figure DEM-5. Sketch of Discriminator Curve Seen at TP4 with 1.0 Volt 0 to 10 mc Sweep Applied to J2

MAINTENANCE

Improper operation of the demodulator is due in most instances to weak or defective tubes. Tubes must be replaced with the exact types specified, and some care should be taken to obtain proper matching when one or both tubes of a pair are replaced.

Demodulator Balance Adjustment

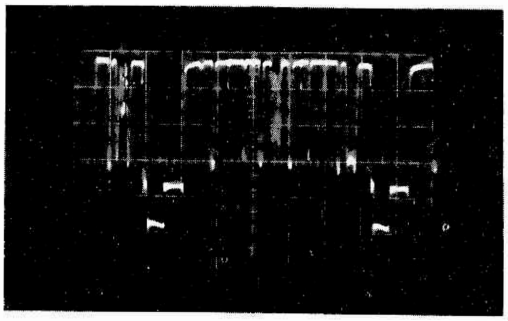
1. Place NORMAL/MOD-DEMOD toggle switch, located on the control panel (unit 305), in MOD-DEMOD position.

2. Turn COLOR-VAR-MONO switch on demodulator to MONO position and make sure CHROME-MONO switch on modulator is in MONO position.

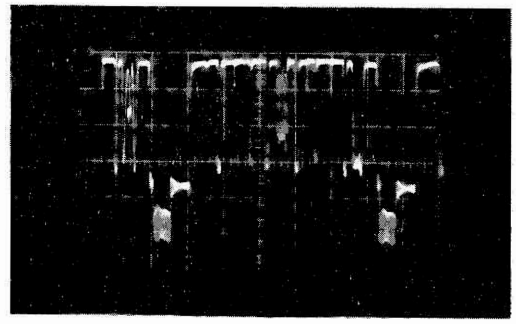
3. Place NORMAL/ROLL-OFF switch in NORMAL position.

4. Press DEMOD OUT pushbutton on CRO/MON switcher (unit 307) and observe waveform on waveform monitor.

5. Adjust potentiometers R50 (PHASE BAL) and R107 (CARRIER BAL) for the least carrier unbalance of the video output signal at blanking level (figure DEM-6).

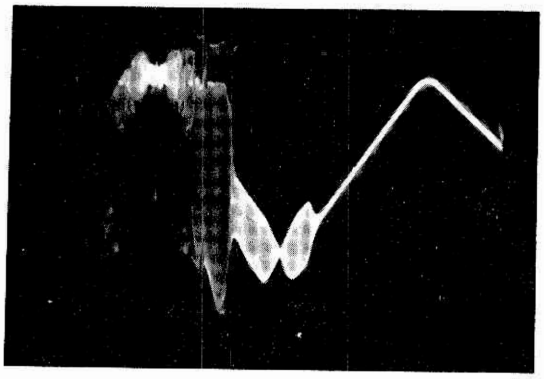


A. Balance Controls Set Correctly

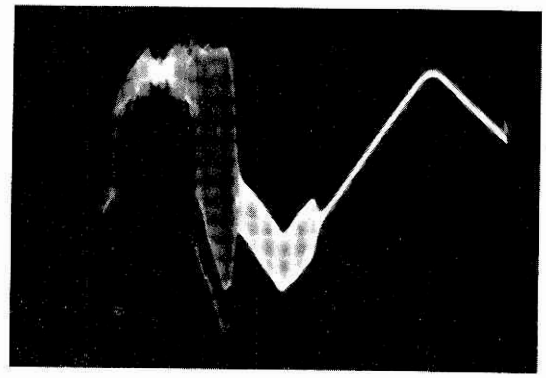


B. Balance Controls Set Incorrectly

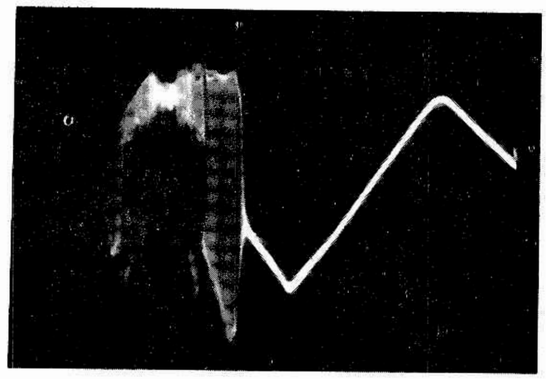
Figure DEM-6. Output Waveform at TP4 (Monoscope Signal; Machine in SETUP)



A. Phase Unbalance Caused by Misadjustment of R50 (PHASE BAL). R107 Correctly Adjusted.



B. Amplitude Unbalance Caused by Misadjustment of R107 (CARRIER BAL). R50 Correctly Adjusted.



C. R50 and R107 Correctly Adjusted.

Figure DEM-7. Output Waveforms at TP4 (VIDEO OUT) with Sweep Input

Demodulator Balance (Alternate Method)

The procedure outlined below should be followed whenever the video output signal cannot be balanced by the above adjustments. A list of test equipment required consists of the following:

1. Video sweep generator (0 to 10 mc sweep).

2. Wide-band oscilloscope (Tektronix Type 535 or equivalent).

To balance the video output signal, proceed as follows:

1. Connect the sweep generator to jack J2 (SW. IN.).

2. Terminate demodulator output with 75 ohms at jack J4 (VID OUT).

3. Adjust sweep generator output to 1 volt peak-to-peak.

4. Turn COLOR-VAR-MONO switch to MONO position and place NORMAL/ROLL-OFF switch in NORMAL position.

5. Connect oscilloscope to test point TP4 (VIDEO OUT). The waveform should appear as indicated by solid lines in figure DEM-5.

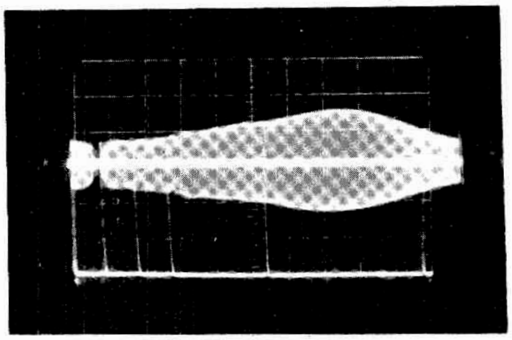
6. If an unbalanced condition exists, as indicated by the dotted lines in figure DEM-5, minimize the unbalance by adjusting potentiometers R50 (PHASE BAL) and R107 (CARRIER BAL).

NOTE: Variable capacitor C54 also affects the waveform balance. This capacitor has been properly adjusted at the factory and should not normally need readjustment, except in the event tube V14 or components in the cathode circuits of V14 have been replaced.

Figure DEM-7 indicates the effect of phase and amplitude unbalance in the output waveform and also shows the correctly balanced waveform.

Inability to obtain a balanced output waveform by the above procedure may indicate an excessive mismatch of 6BN6 tubes V15, V16. A rapid check of these tubes may be made by interchanging them in their sockets and readjusting potentiometer R107 (CARRIER BAL). If R107 must be rotated more than 1/8 turn to approach a balanced output waveform, the tubes must be more evenly matched.

A check on the equality of amplification of the push-pull channels may be made by sweeping the input, as described in steps 1 through 4 above, and



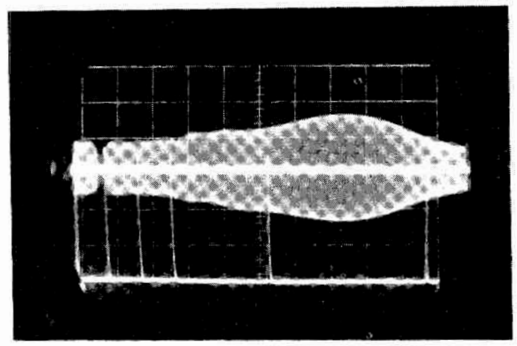


Figure DEM-8. Sweep Response at TP2 (left) and TP3 (right) with Sweep Input Level Attenuated Below Limiting (Frequency Markers at 0, 1, 2, 5 and 10 mc)

observing the frequency response at test points TP2 (DELAYED PHASE) and TP3 (UNDELAYED PHASE) at the cathodes of phase splitter V14. When the sweep generator input is reduced so that the amplifiers are not limiting, the response observed at TP2 and TP3 should be equal in amplitude and shape (±10%) to approximately 8 mc (figure DEM-8).

RF Copy Balance

The rf copy balance control may need infrequent adjustment. When making this adjustment, follow the procedure outlined below using an oscilloscope at the rear of the demodulator chassis.

1. Remove the connection from RF COPY OUT (J9) and terminate with 75 ohms. Rotate RF COPY OUT control (R75) to maximum position (clockwise).

2. With no signal input to the modulator, press RF COPY and SETUP pushbuttons on the control panel. This permits the modulator carrier frequency to appear at the output (J9) of the rf copy circuit.

3. Place oscilloscope input probe at jack J9.

4. Short out one of the rf copy channels by inserting a .01 μfd capacitor between pin 7 of V11 and ground.

5. Adjust RF COPY BAL (R69) for maximum output at J9 and note carrier amplitude.

6. Remove the .01 μfd capacitor from pin 7 of V11 and place it between pin 2 of V10 and ground, shorting out the other rf copy channel, and note the carrier amplitude at J9.

7. The amplitudes obtained in steps 5 and 6 should agree within 20%. (It may be necessary to repeat the above procedure until the proper balance is obtained.)

8. Remove the .01 μfd capacitor and adjust RF COPY OUT control for 1 ±.2 volts peak-to-peak.

NOTE: Refer to figure DEM-12 for typical examples of rf copy output waveforms.

Overall Gain

The demodulator provides a minimum of 50 db limiting to eliminate fluctuations in video amplitude due to amplitude modulation of the carrier, carrier "bounce", tape dropouts, or other irregularities in carrier amplitude. Inability to obtain the minimum limiting is generally due to weak tubes. Test equipment required in checking the limiting of the demodulator consists of the following:

1. Wide-band oscilloscope (Tektronix Type 535 or equivalent).

2. Low-capacity oscilloscope attenuator probe.

3. Calibrated rf attenuator.

To determine the limiting of the demodulator, proceed as follows:

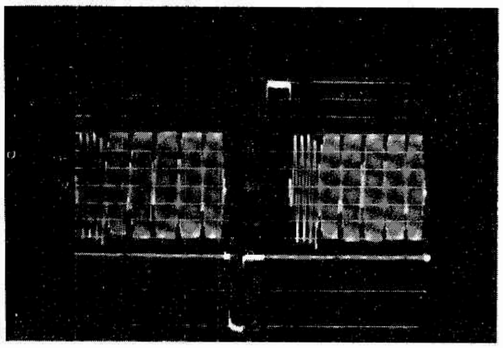
1. Place NORMAL/MOD-DEMOD toggle switch, located on the control panel (unit 305), in MOD-DEMOD position.

2. Connect the rf attenuator, in series with the input from the modulator, to input jack J6 (FM IN).

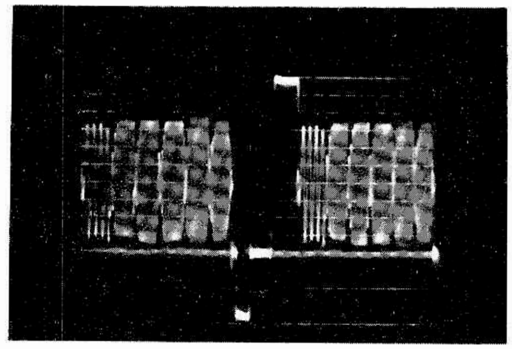
3. Set the attenuation to zero and check the modulator output for 1 volt peak-to-peak, using the oscilloscope with the probe connected to test point TP1 (FM INPUT).

4. Move the probe to test point TP4 (VIDEO OUT) and observe the output signal.

5. Increase attenuation until peak-to-peak video output signal decreases 10%. The attenuation inserted in series with the input signal determines the amount of limiting obtained.



A. Video Input to Modulator (VID IN on CRO Monitor)



B. Video Output from Demodulator (DEMOD OUT on CRO Monitor)

Figure DEM-9. Waveforms Obtained with Multiburst Input Signal Applied to Machine

Video Frequency Response Adjustment

The overall video frequency response of the modulator and demodulator should be flat ($\pm 1\frac{1}{2}$ db) to 4 megacycles. To adjust the frequency response, follow the procedure outlined below:

1. Place machine in SETUP.

2. Set modulator and demodulator switches to MONO position, and demodulator NORMAL/ROLL-OFF switch to NORMAL position.

3. Apply a multiburst signal to input of machine. (Telechrome Model 1003C recommended).

4. Press oscilloscope VID IN pushbutton on CRO/MON switcher (unit 307) and observe input signal waveform on CRO monitor (unit 306).

5. Adjust multiburst input signal so that the waveform amplitude is as shown in figure DEM-9A. (100% amplitude high frequency bursts cannot be used because pre-emphasis of the video signal causes the deviation of the fm carrier to exceed the knee of the demodulator characteristic).

6. Adjust modulator sync tip and white tip frequencies as described in IB-31133 (modulator, unit 102).

7. Press oscilloscope DEMOD OUT pushbutton on CRO/MON switcher and observe demodulator output signal on CRO monitor.

8. Adjust gain of distribution amplifier No. 2 (unit 303) for blanking at 0 and white bar at 100 IRE units.

9. For monochrome machines, adjust variable capacitor C67 (rear of demodulator) so that amplitudes of the bursts extend from 10 to 70 IRE units as shown in figure DEM-9B. (Approximately ± 10 IRE units are allowed within the specification of $\pm 1\frac{1}{2}$ db).

For color machines, adjust C67 for unity 3.6 mc burst (60 IRE units).

NOTE: The higher frequency bursts observed on the output contain beats. The true amplitude of any given burst extends from halfway between the minimum and maximum of the beat at the top of the burst to halfway between the minimum and maximum of the beat at the bottom of the burst.

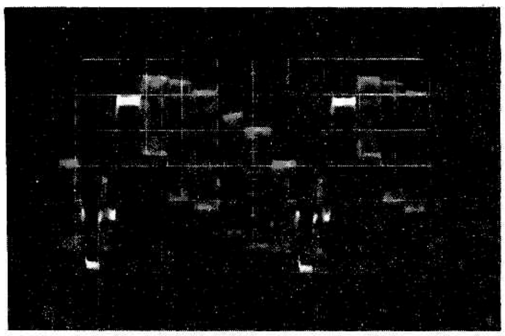
Output Level

All tubes from the 6BN6 discriminator tubes (V15 and V16) to output tube V19 determine the output level of the demodulator. Therefore, difficulty in obtaining an output level of 0.7 volt peak-to-peak indicates a tube or component failure in one of these stages. The output level, as observed on the waveform monitor when the DEMOD OUT pushbutton on the CRO/MON switcher is pressed, is adjusted to 1 $\pm .2$ volt peak-to-peak at the output of distribution amplifier No. 2 (unit 303).

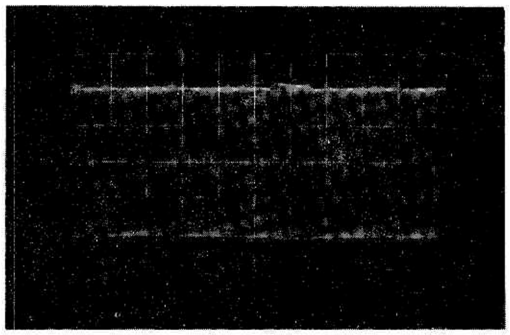
Waveforms and Voltages

Figures DEM-10 to DEM-12 show typical waveforms, with amplitudes, obtained throughout the unit for use as an aid in trouble shooting. All waveforms were obtained with a Tektronix Type 535 oscilloscope having a 10:1 attenuator probe and with the machine in SETUP (in RF COPY SETUP in figure DEM-12). Also, both modulator and demodulator COLOR-MONO switches were in MONO position.

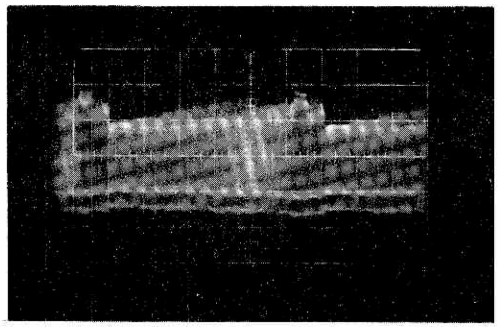
The *Voltage Table,* adjacent to the schematic diagram (figure DEM-14), indicates typical tube socket voltages with respect to ground measured with a vacuum-tube voltmeter. All voltages are dc unless otherwise noted.



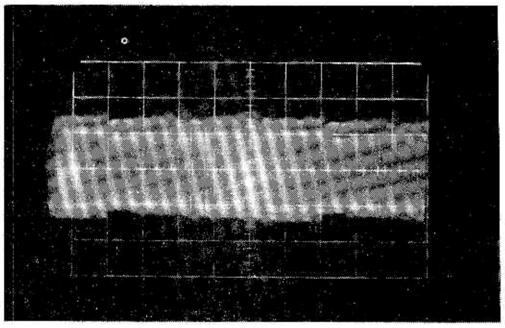
A. Modulator Input Signal at TP1 (Machine in RECORD or SETUP). 0.2 volt/division



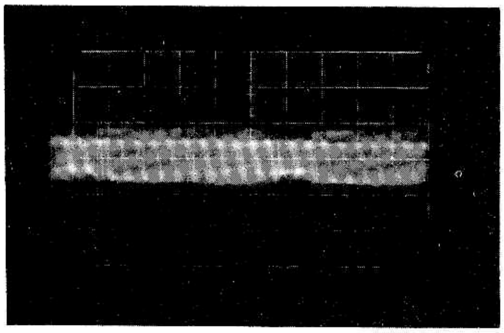
B. Demodulator Input Signal at TP1 (Machine in RF COPY or RF COPY and RECORD). 0.2 volt/division



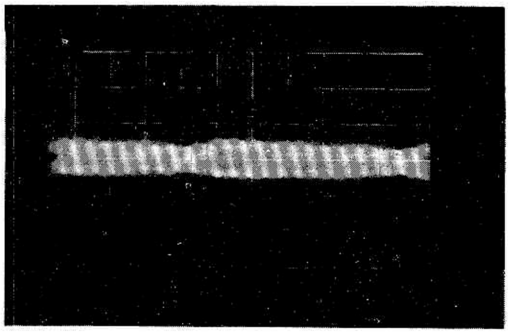
C. V2 pin 7. 0.5 volt/division



D. V4 pin 7. 0.5 volt/division

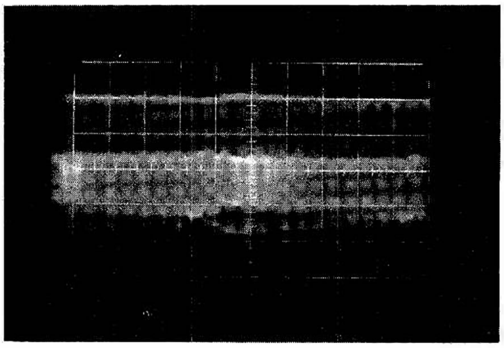


E. V6 pin 7. 0.5 volt/division

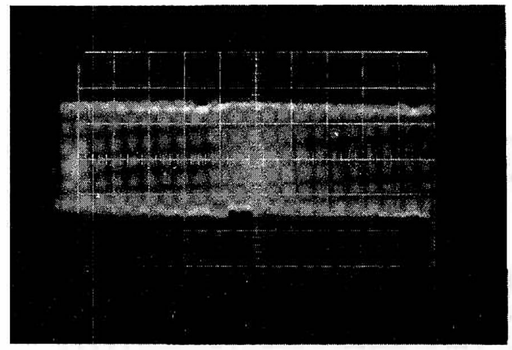


F. V8 pin 7. 0.5 volt/division

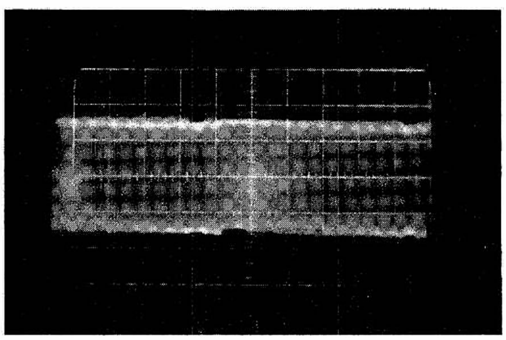
Figure DEM-10. Typical Waveforms



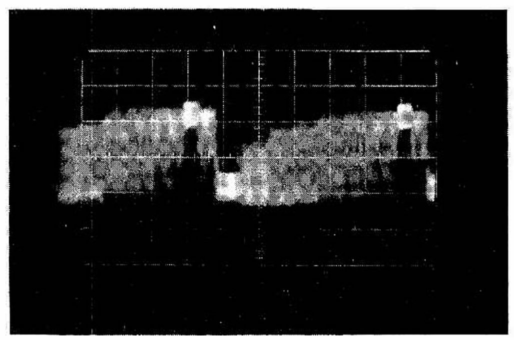
A. V12 pin 1 (PHASE BAL minimum). 0.5 volts/division



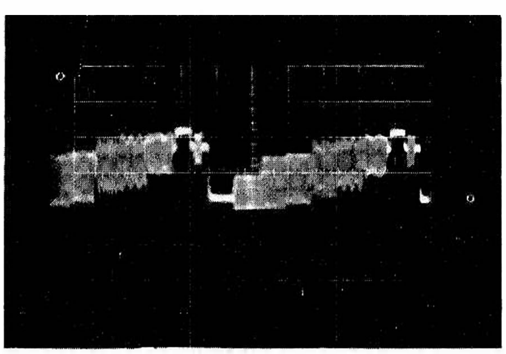
B. V14 pin 3 (TP2). 5 volts/division



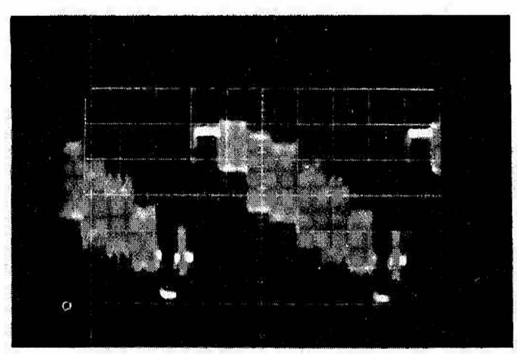
C. V14 pin 8 (TP3). 5 volts/division



D. V17B pin 6. .05 volts/division

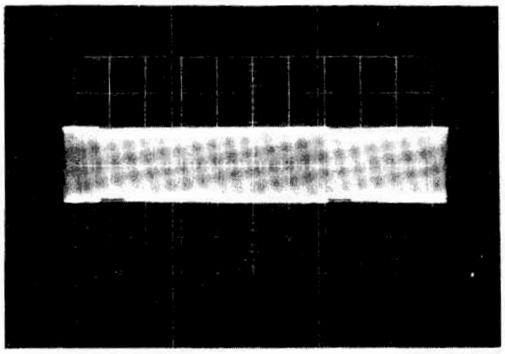


E. V18 pin 1. .05 volts/division

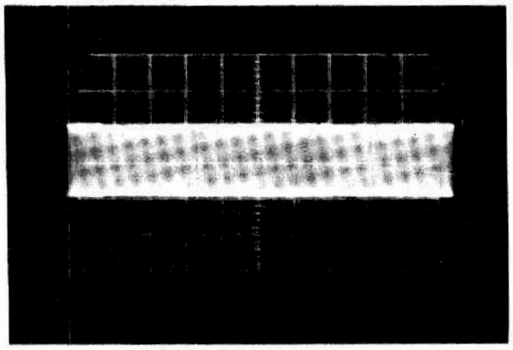


F. Video Output (TP4). 0.2 volts/division

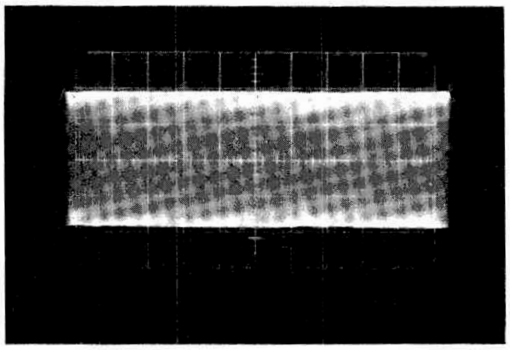
Figure DEM-11. Typical Waveforms



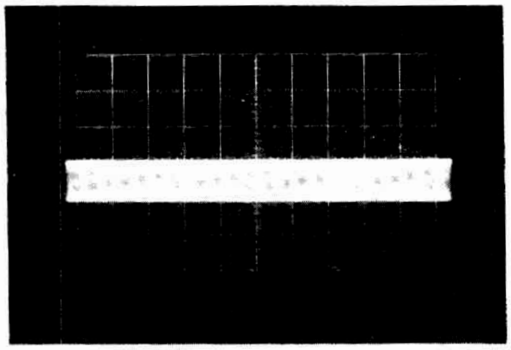
A. RF COPY OUT—maximum; RF COPY BAL—maximum output. (One rf copy input grounded by .01 ufd capacitor from V9 pin 5 to ground.) 0.5 volt/division



B. Same as DEM-12A except other rf copy input grounded by .01 ufd capacitor from V8 pin 5 to ground



C. RF COPY OUT—maximum. 0.5 volt/division



D. RF COPY OUT—minimum. 0.5 volt/division

Figure DEM-12. Typical Waveforms at RF Copy Output (J9) with Output (RF COPY OUT) and Balance (RF COPY BAL) Controls Positioned as Indicated

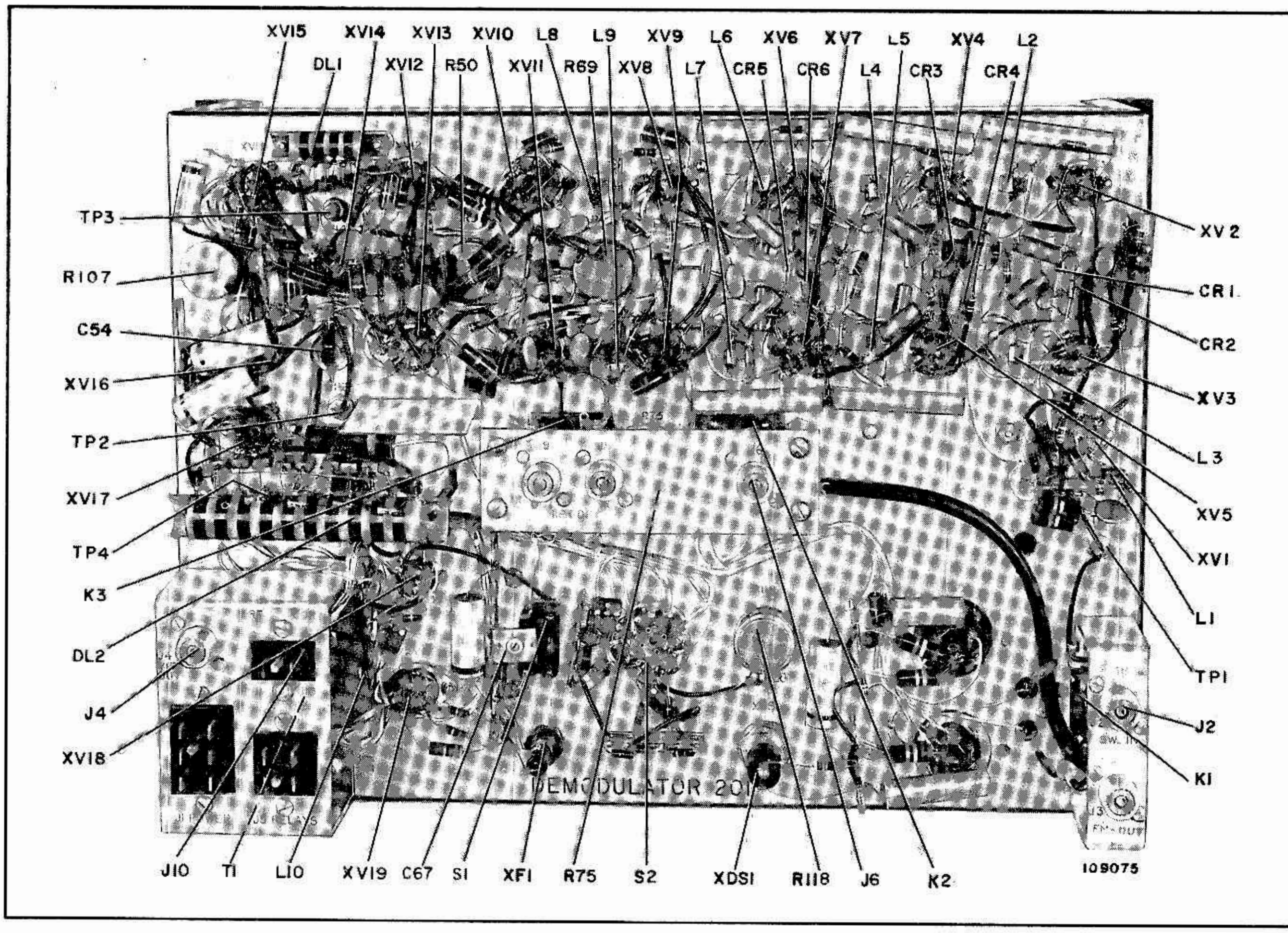


Figure DEM-13. Rear View of Demodulator

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			DEMODULATOR, (8515298-501) 8
			CAPACITORS:
C1, C2		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C3, C4		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C5, C6		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C7		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C8		727851-102	mica, 10 μμf ±10%, 500 v char "B"
C9		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C10, C11		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C12			Not Used
C13 to C16		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C17, C18		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C19			Not Used
C20 to C23		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C24, C25		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C26			Not Used
C27 to C30		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C31, C32		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C33, C34		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C35, C36		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C37, C38		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C39			Not Used
C40		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
C41 to C44		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C45,C46			Not Used
C47		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C48		990786-375	plastic, 0.1 μf ±10%, 400 v
C49 to C53		8811182-7	ceramic, 1000 μμf -20 +100%, 500 v
C54	56690	984003-10	variable, ceramic, 1.5/7 μμf
C55A/D	98408	458558-5	electrolytic, 20/20/20/20 μf 450 v
C56,C57		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C58,C59		990786-379	plastic, 0.22 μf ±10%, 400 v
C60		735715-175	paper, 0.1 μf ±10%, 400 v
C61		748252-206	mica, 6 μμf ±10%, 500 v, char "C"
C62		990786-379	plastic, 0.22 μf ±10%, 400 v
C63		727853-230	mica, 200 μμf ±5%, 500 v, char "D"
C64		727853-235	mica, 330 μμf ±5%, 500 v, char "D"
C65A/D	98408	458558-5	electrolytic, 20/20/20/20 μf 450 v
C66		990786-379	plastic, 0.22 μf ±10%, 400 v
C67	223861	8901210-8	trimmer, 110/580 μμf
C68		727853-137	mica, 390 μμf ±10%, 500 v, char "D"
C69		727853-133	mica, 270 μμf ±10%, 500 v, char "D"
C70A/B	209267	458558-2	electrolytic, 1000/1000 μf 15 v
C71		990786-379	plastic, 0.22 μf ±10%, 400 v
C72		727853-235	mica, 330 μμf ±5%, 500 v, char "D"
C73 to C76		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
CR1 to CR6	218493		Diode: type 1N270
DS1	101857	872291-9	Lamp: indicator
DL1	223457	8438311-514	Line: delay
	78912	90575-407	Capacitor: ceramic, 4 μμf ±.25 μμf
	218241	8914319-18	Capacitor: mica, 56 μμf ±1%, 500 v
DL2	218167	8438311-511	Line: delay
	99582	90575-409	Capacitor: ceramic, 5 μμf ±.25 μμf
	219421	748252-426	Capacitor: mica, 62 μμf ±2%, 500 v
F1	53447	990157-108	Fuse
J1	51604	727969-3	Connector: male, 6 contact
J2 to J4	51800	255223-2	Connector: coax, chassis mtg.
J5	52107	727969-13	Connector: male, 4 contact
J6	51800	255223-2	Connector: coax, chassis mtg.
J7			Not Used
J8,J9	51800	255223-2	Connector: coax, chassis mtg.
J10	222659	727969-31	Connector: male, 2 contact
K1 to K3	218165	470678-5	Relay: 24 v S.P.D.T. with 2 micro switches
	212301		Micro Switch only for K1
L1 to L9	202910	8825473-505	Coil: choke, 10 microhenry
L10	210343	8825473-503	Coil: 6 microhenry
P1	51607	727969-4	Connector: female, 6 contacts
P2 to P4			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adaptor - solder type
P5	52108	727969-14	Connector: female, 4 contact
P6			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adaptor - solder type
P7			Not Used
P8,P9	210715	8909771-501	Termination: coax
P10		727969-30	Connector: female, 2 contacts
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		82283-132	75 ohms, ±5%, ½ w
R2,R3			Not Used
R4		99126-74	10,000 ohms, ±10%, 2 w
R5		90496-161	1200 ohms, ±5%, 1 w
R6		82283-74	10,000 ohms, ±10%, ½ w
R7		82283-52	150 ohms, ±10%, ½ w
R8		99126-74	10,000 ohms, ±10%, 2 w
R9		82283-151	470 ohms, ±5%, ½ w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R10		82283-82	47,000 ohms, ±10%, ½ w
R11		82283-142	200 ohms, ±5%, ½ w
R12		82283-145	270 ohms, ±5%, ½ w
R13		82283-60	680 ohms, ±10%, ½ w
R14		82283-56	330 ohms, ±10%, ½ w
R15,R16		82283-82	47,000 ohms, ±10%, ½ w
R17,R18	221876	8515216-389	film, 8250 ohms, ±1%, 2 w
R19		82283-54	220 ohms, ±10%, ½ w
R20		82283-212	160,000 ohms, ±5%, ½ w
R21		82283-202	62,000 ohms, ±5%, ½ w
R22,R23		82283-200	51,000 ohms, ±5%, ½ w
R24		82283-54	220 ohms, ±10%, ½ w
R25	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R26,R27	215166	8515214-285	film, 750 ohms, ±1%, ½ w
R28	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R29,R30		82283-82	47,000 ohms, ±10%, ½ w
R31,R32	221876	8515216-389	film, 8250 ohms, ±1%, 2 w
R33		82283-54	220 ohms, ±10%, ½ w
R34,R35		82283-200	51,000 ohms, ±5%, ½ w
R36		82283-94	470,000 ohms, ±10%, ½ w
R37	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R38,R39	215166	8515214-285	film, 750 ohms, ±1%, ½ w
R40	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R41		82283-212	160,000 ohms, ±5%, ½ w
R42		82283-202	62,000 ohms, ±5%, ½ w
R43,R44		82283-82	47,000 ohms, ±10%, ½ w
R45,R46	221876	8515216-389	film, 8250 ohms, ±10%, ½ w
R47		82283-54	220 ohms, ±10%, ½ w
R48,R49		82283-200	51,000 ohms, ±5%, ½ w
R50	98221	8971860-105	variable, 500 ohms, ±10%, 2 w
R51	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R52,R53	215166	8515214-285	film, 750 ohms, ±1%, ½ w
R54	214882	8515214-201	film, 100 ohms, ±1%, ½ w
R55,R56		82283-82	47,000 ohms, ±10%, ½ w
R57,R58		99126-181	8200 ohms, ±5%, 2 w
R59,R60		82283-200	51,000 ohms, ±5%, ½ w
R61,R62		82283-152	510 ohms, ±5%, ½ w
R63		99126-161	1200 ohms, ±5%, 2 w
R64,R65		90496-142	200 ohms, ±5%, 1 w
R66		82283-94	470,000 ohms, ±10%, ½ w
R67		82283-42	22 ohms, ±10%, ½ w
R68		82283-57	390 ohms, ±10%, ½ w
R69	98956	9871860-106	variable, 1000 ohms, ±10%, 2 w
R70,R71		82283-126	43 ohms, ±5%, ½ w
R72		82283-42	22 ohms, ±10%, ½ w
R73,R74		82283-44	33 ohms, ±10%, ½ w
R75	99671	8971860-104	variable, comp., 250 ohms, ±10%, 2 w
R76		82283-126	43 ohms, ±5%, ½ w
R77		99126-161	1200 ohms, ±5%, 2 w
R78		90496-142	200 ohms, ±5%, 1 w
R79		82283-55	270 ohms, ±10%, ½ w
R80		82283-94	470,000 ohms, ±10%, ½ w
R81		90496-142	200 ohms, ±5%, 1 w
R82		82283-212	160,000 ohms, ±5%, ½ w
R83		82283-202	62,000 ohms, ±5%, ½ w
R84		82283-82	47,000 ohms, ±10%, ½ w
R85 to R88		99126-174	4300 ohms, ±5%, 2 w
R89		82283-82	47,000 ohms, ±10%, ½ w
R90,R91		90496-174	4300 ohms, ±5%, 1 w
R92		90496-50	100 ohms, ±10%, 1 w
R93		82283-149	390 ohms, ±5%, ½ w
R94		90496-157	820 ohms,±5%, 1 w
R95		82283-156	750 ohms, ±5%, ½ w
R96			Not Used
R97		82283-216	240,000 ohms, ±5%, ½ w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R98		82283-190	20,000 ohms, ±5%, ½ w
R99		82283-82	47,000 ohms, ±10%, ½ w
R100		99126-63	1200 ohms, ±10%, 2 w
R101, R102		90496-167	2200 ohms, ±5%, 1 w
R103		82283-82	47,000 ohms, ±10%, ½ w
R104, R105		82283-175	4700 ohms, ±5%, ½ w
R106		82283-141	180 ohms, ±5%, ½ w
R107	56596	8971860-108	variable, 2500 ohms, ±10%, 2 w
R108		82283-141	180 ohms, ±5%, ½ w
R109, R110		90496-167	2200 ohms, ±5%, 1 w
R111, R112		82283-175	4700 ohms, ±5%, ½ w
R113, R114		99126-86	100,000 ohms, ±10%, 2 w
R115, R116		82283-152	510 ohms, ±5%, ½ w
R117		82283-76	15,000 ohms, ±10%, ½ w
R118	52011	433196-17	variable, 2000 ohms, ±10%, 2 w
R119		82283-50	100 ohms, ±10%, ½ w
R120		82283-98	1 meg ±10%, ½ w
R121		82283-66	2200 ohms, ±10%, ½ w
R122		82283-45	39 ohms, ±10%, ½ w
R123		82283-98	1 meg ±10%, ½ w
R124		82283-50	100 ohms, ±10%, ½ w
R125	94885	458572-63	wire wound, 3500 ohms, ±5%, 5 w
R126		82283-165	1800 ohms, ±5%, ½ w
R127		82283-163	1500 ohms, ±5%, ½ w
R128		82283-98	1 meg ±10%, ½ w
R129		82283-163	1500 ohms, ±5%, ½ w
R130		82283-144	240 ohms, ±5%, ½ w
R131		82283-146	300 ohms, ±5%, ½ w
R132			Not Used
R133, R134		82283-135	100 ohms, ±5%, ½ w
R135		82283-50	100 ohms, ±10%, ½ w
R136		82283-98	1 meg ±10%, ½ w
R137		82283-62	1000 ohms, ±10%, ½ w
R138		82283-66	2200 ohms, ±10%, ½ w
R139	54229	8817660-17	wire wound, 3000 ohms, ±10%, 10 w
R140		82283-48	68 ohms, ±10%, ½ w
R141		90496-56	330 ohms, ±10%, 1 w
R142		90496-38	10 ohms, ±10%, 1 w
R143			Pt. of XDS1
R144		82283-94	470,000 ohms, ±10%, ½ w
R145		99126-75	12,000 ohms, ±10%, 2 w
R146		82283-139	150 ohms, ±5%, ½ w
R147		82283-155	680 ohms, ±5%, ½ w
R148		82283-111	10 ohms, ±5%, ½ w
R149		82283-183	10,000 ohms, ±5%, ½ w
R150		82283-148	360 ohms, ±5%, ½ w
R151		82283-148	360 ohms, ±5%, ½ w
R152		82283-150	430 ohms, ±5%, ½ w
S1	93263	95559-5	Switch: toggle, D.P.D.T.
S2	56584	8983928-1	Switch: rotary, 4 pole, 3 pos.
T1	95539	450031-3	Transformer
TP1 to TP4	208983	8825493-7	Jack: tip, yellow
V2 to V9	209149		Tube: type 6485
XADS1	208080	990788-507	Jewel: indicator light
XDS1	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XV1	94926	737870-14	Socket: tube, 9 pin
XV2 to XV9	94925	737867-14	Socket: tube, 7 pin
XV10 to XV14	94926	737870-14	Socket: tube, 9 pin
XV15, XV16	94925	737867-14	Socket: tube, 7 pin
XV17	94926	737870-14	Socket: tube, 9 pin
XV18	94925	737867-14	Socket: tube, 7 pin
XV19	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	34950	845607-1	Knob: black

VOLTAGE TABLE

Tube Symbol	Tube Type	Pin Number 1	2	3	4	5	6	7	8	9
V1	12AV7	155	2.75	4.85	*	*	148	0	1.7	GND
V2	6485	74	GND	6.3 ac	GND	265	190	76	NC	NC
V3	6485	74	GND	6.3 ac	GND	265	185	76	NC	NC
V4	6485	74	GND	6.3 ac	GND	265	180	75	NC	NC
V5	6485	74	GND	6.3 ac	GND	265	180	75	NC	NC
V6	6485	77	GND	6.3 ac	GND	268	185	78.5	NC	NC
V7	6485	77	GND	6.3 ac	GND	268	182	78.5	NC	NC
V8	6485	77	GND	6.3 ac	GND	271	190	79	NC	NC
V9	6485	77	GND	6.3 ac	GND	271	185	79	NC	NC
V10	5687	255	—	134	**	**	3.9	0	GND	130
V11	5687	255	130	135	**	**	4.0	0	GND	130
V12	6CL6	82	77	236	6.3 ac	GND	250	NC	236	77
V13	6CL6	82	77	234	6.3 ac	GND	260	NC	234	77
V14	12AV7	225	22	25.5	*	*	225	22	25.5	GND
V15	6BN6	2.8	2.0	6.3 ac	GND	27.5	2.3	28.8	NC	NC
V16	6BN6	2.1	1.3	6.3 ac	GND	27.5	1.6	28.8	NC	NC
V17	6U8A	190	45	195	6.3 ac	GND	190	58	58	57
V18	6CB6	1.2	2.4	6.3 ac	GND	127	135	GND	NC	NC
V19	6CL6	16.2	13.4	152	6.3 ac	GND	152	GND	152	13.4

* 6.3 volts ac between pin 9 and either of pins 4 or 5.
** 6.3 volts ac between pin 8 and either of pins 4 or 5.

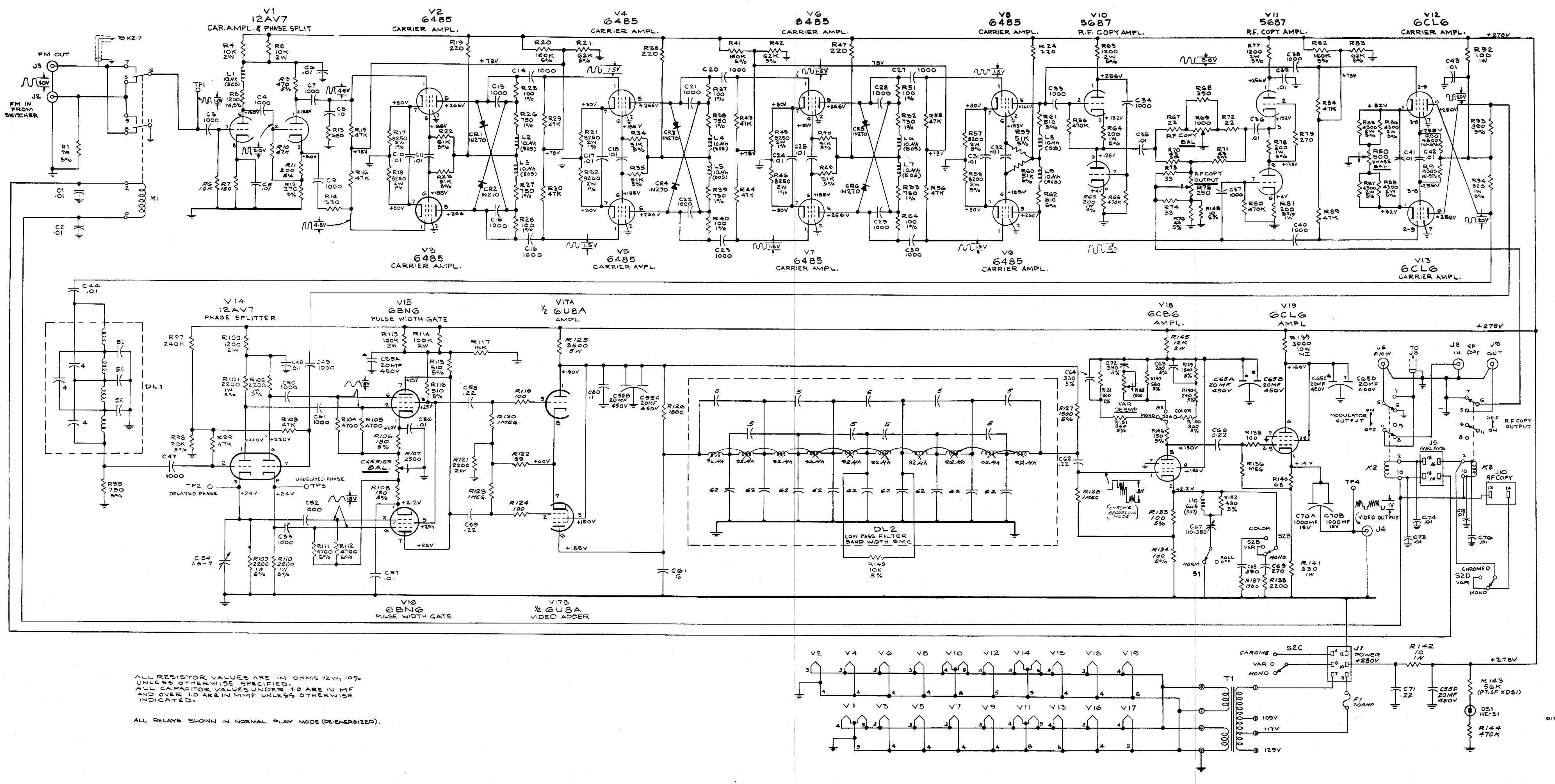


Figure DEM-14. Demodulator Schematic Diagram

Tape Transport Panel

UNIT 200

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
GO 6101

IB-31139

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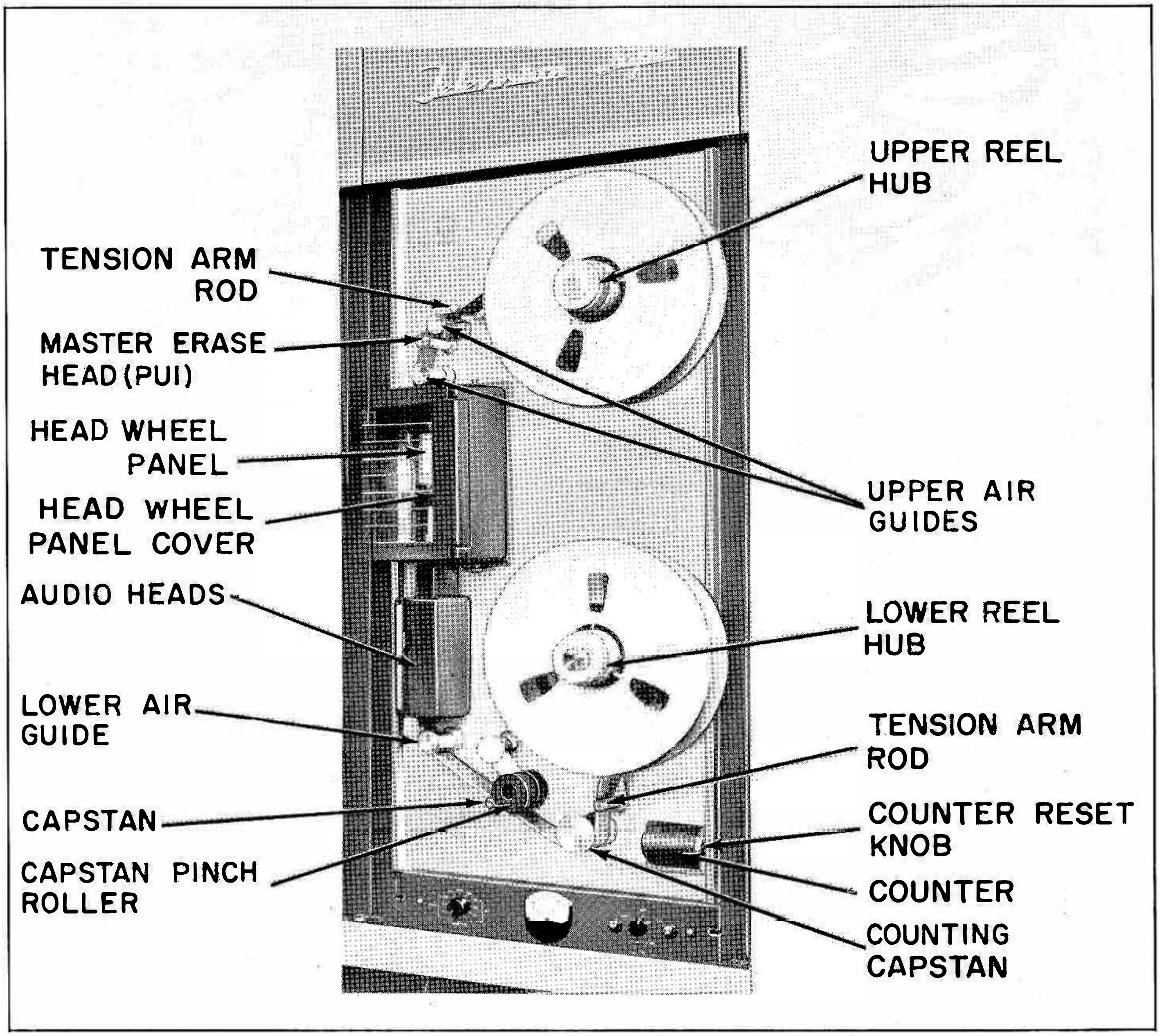

Figure TTP-1. Tape Transport Panel

DESCRIPTION

The Tape Transport Panel (fig. TTP-1) is located in the operations center between the control panel, on the right, and the picture monitor, on the left. Its purpose is to convey the magnetic tape over the necessary recording and pickup heads, while maintaining correct tape speed and tension to give the required performance.

The structural support for the tape transport panel consists of a cast aluminum plate precision ground on both sides to a thickness of one-half inch. Along each edge it is fastened to a two by three inch extruded aluminum angle. The angles are in turn fastened to the rack frame. All assemblies and components are fastened to the aluminum plate.

The upper reel supplies the tape (fig. TTP-1) to be recorded upon or played back from. The lower reel is for tape storage. The tape from the upper reel passes under the upper tension arm rod, the purpose of which is to take up the excess tape in the event of erratic motion. After passing under the upper tension arm the tape passes over the master erase head. Preceding and following the master erase head are two air guides which position the tape for its approach to the video headwheel. The master erase head is energized in the record mode of operation only; it erases any previously recorded signals. After passing over the erase head and air guides the tape comes to the video headwheel where the video and control signals are either recorded onto or read from the tape by the headwheel assembly. After leaving the headwheel assembly the tape passes the audio heads. The lower air guide changes the direction of the tape for its approach to the capstan which controls the tape speed. After leaving the capstan the tape passes over the counting capstan which is rotated by the tape and thus counts the length of tape in minutes and seconds of playing time. The tape from the counting capstan passes under the lower tension arm post, which performs the same function as the upper tension arm, and onto the take-up reel.

During rewind, the upper reel motor is fully energized and starts at a maximum speed of 875 rpm which decreases as the reel fills. During maximum speed rewind, the lower motor is energized to rotate counterclockwise with an applied voltage of approximately 50 volts. However, its direction of rotation is clockwise and its speed is determined by the tape speed which increases with the radius of the upper reel. In the play mode the motors operate at a constant torque. The supply motor operates at slightly below 25-inch ounces; and the take-up motor at 50-inch ounces.

The reel hub assemblies (fig. TTP-7) support the tape reels and hold them securely to the motor shafts. There are three pawls that clamp the reel against the flange of the hub. The hub is secured to the motor shaft and has three equally positioned slots in which the three pawls ride. Turning the knob in a counterclockwise direction causes the pawls to retract to allow removal of the reel. Turning the knob in a clockwise direction causes the pawls to clamp the reel.

Reel Motor and Brake Assembly

The reel-motor, hub, and brake assemblies (figs. TTP-2, TTP-5, and TTP-8) are key units in the handling of tape. The reel motors supply power to hold back or take up the tape. The hub assembly supports the reel and tape, and the brakes operate to bring the reels to a safe stop.

The reel motors are of the induction torque design, with a rating of 65 inch-ounces at 75 volts. The front flange of the motor is used to fasten it to the mounting plate; on the rear flange is mounted the brake assembly. The complete assembly of motor, hub, and brake can be easily removed from the tape transport panel for repair.

The brakes are fail-safe since they are spring actuated and solenoid released. Braking is done by an asbestos lined band on a brass drum. The linkage is arranged to give differential braking depending on the direction of rotation. Differential braking is required to prevent tape slack when going from high speed WIND or high speed REWIND to STOP.

Capstan, Pinch Roller, and Linkage

The capstan motor (figs. TTP-1, TTP-2, and TTP-4) controls the tape speed. Its shaft is sized to give a tape speed of 15 inches per second at a speed of 600 rpm. It is a hysteresis, synchronous, two-phase motor with a rated running torque of 11 inch-ounces. To smooth out speed fluctuations, a flywheel is mounted on the other end of the capstan motor shaft.

The pinch roller assembly (fig. TTP-10) is a self-aligning split roller design utilizing the controlled looseness of ball bearings. There is sufficient freedom of the shaft, in the arm and each roller on the shaft, to allow the rollers to align with the capstan shaft. The actuation of the pinch rollers is done by a rotary solenoid through a spring loaded link. The spring

loaded link in conjunction with a link on the rotary solenoid shaft provide a knuckle action which reduces the holding torque required of the solenoid. This action utilizes most of the rotary stroke for moving the pinch rollers to the contact point therefore providing adequate clearance. The final 15 degrees of stroke is used to compress the spring link; therefore, providing the force necessary to hold the pinch rollers against the tape and capstan. This spring force is adjustable, but does not change with variations in solenoid torque.

Counting Capstan and Counter

To measure the length of tape used, a counting capstan (figs. TTP-1, TTP-2, and TTP-9) is incorporated. It is geared to the counter through a small drive shaft parallel to the panel. The counting capstan diameter and spur gears are designed to give one count for each 15 inches of tape. This results in the counter reading minutes and seconds of tape, with a maximum time of 99 minutes and 59 seconds.

Audio Heads and Mounts

Erase heads for the program and cue tracks are mounted in the first support (figs. TTP-1 and TTP-15). The second support holds the cue and program audio heads. Between the first and second support is mounted a back-up post which makes it possible to obtain the proper wrap on each support, yet allow the three supports to be in a straight line. The two heads in the third support provide simultaneous playback of program audio and control track signals. All six heads are adjusted for proper track location. The program audio, cue, and simultaneous audio playback heads are also adjusted for proper azimuth.

Tension Control

In the record and play modes the reel motors are energized to give a fixed torque, regardless of the amount of tape on either reel. The tension of the tap changes because the radius of the reel changes from a minimum of 2.25 to 6.75 inches for a 14-inch diameter reel of tape. This change in tension causes the load on the capstan to change from holding back at the start of a reel to pulling at the end of the reel. In terms of load on the capstan, a representative change would be from -3 to $+2$ inch-ounces from the start to the end of a 7200 foot reel.

The tension arms on this machine serve the function of taking up or paying out tape at a faster rate than can be provided by the reel motor assembly. Unilateral damping has been provided to operate when the tension arms are paying out tape. This is accomplished with unidirectional air dampers mounted on the rear of the support panel and connected to the tension arms. Damping in this manner stabilizes the tape speed more quickly when starting.

Headwheel Blower

The headwheel blower (unit 208) located on the rear of the tape transport panel (fig. TTP-2) is used for cleaning and cooling of the headwheel assembly. A permanently lubricated ball-bearing motor drives a multi-stage blower which draws the air from the headwheel panel over an oil-wetted wire filter. This filter removed the dust and lint collected from the tape and headwheel.

Headwheel Panel Cover

A hinged and removable cover (fig. TTP-1), with an inspection window, is provided to protect the headwheel area. The protective cover can be removed by loosening the captive screws at the bottom and top of the cover and pulling the cover away from the tape transport panel.

Vacuum Guide Positioner Assembly

The vacuum guide positioner assembly (figs. TTP-2, TTP-11, and TTP-12) is the actuator for the vacuum guide position control system. It consists of a phase controlled servo motor gear coupled to a lead screw and a three-turn error potentiometer. The axial location of the lead screw establishes, through a linkage mechanism on the headwheel panel, the position of the vacuum guide. The error potentiometer is so coupled that the amount of resistance seen at the center tap is proportional to the position of the lead screw. This potentiometer functions only when the system is in the manual mode of operation; in the automatic position it is out of the circuit. The ratio of coupling is such that approximately 2.94 turns of the potentiometer give .005 inch movement of the guide. In the manual mode of operation the mechanism is electrically limited to this amount of rotation by means of a bridge control circuit. In the automatic mode of operation, the total excursion is limited only by the mechanical stops on the potentiometer. This potentiometer has a 90-degree over-travel at each end so that the total excursion in the automatic mode is $3\frac{1}{2}$ turns of the potentiometer.

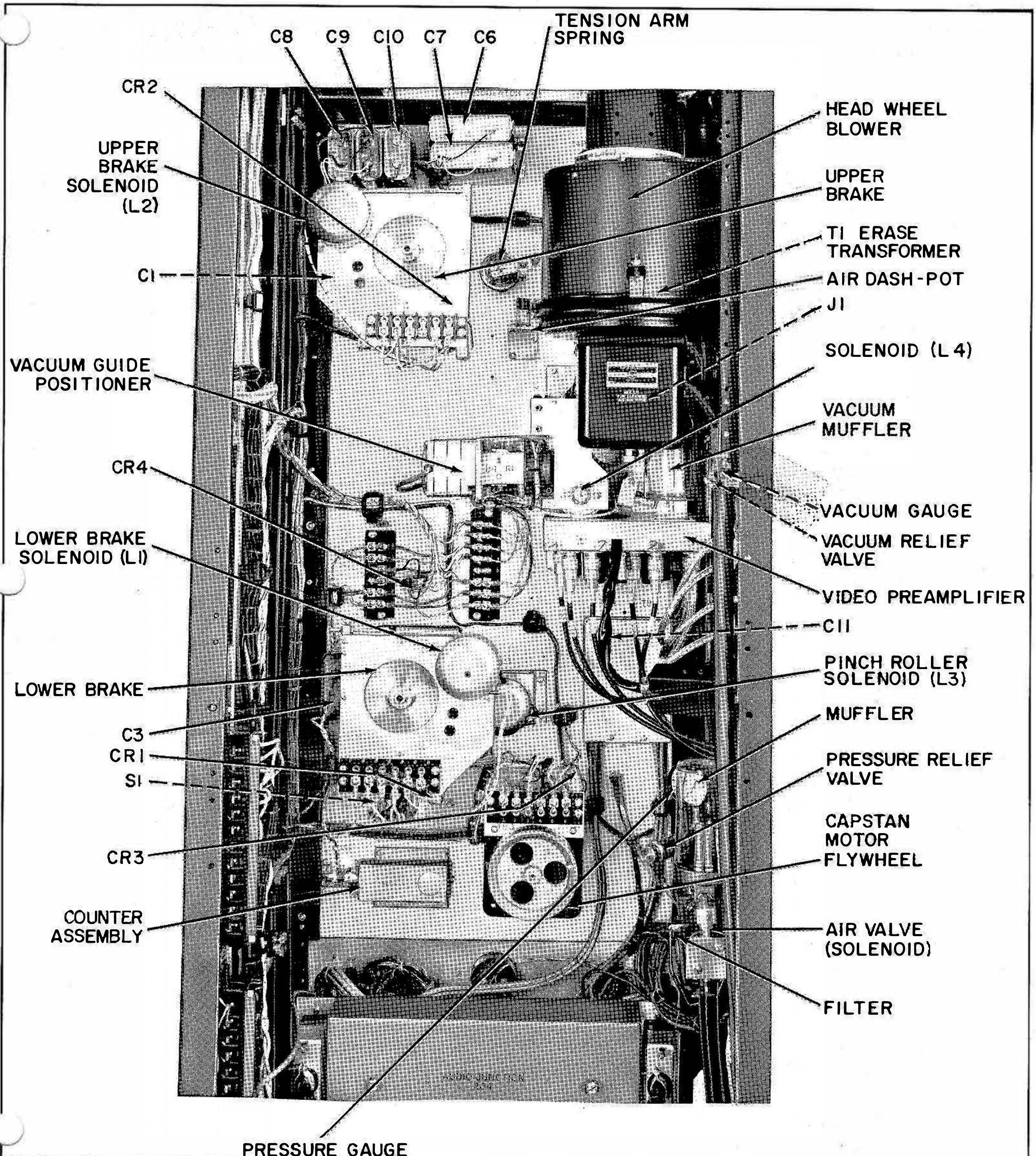

Figure TTP-2. Tape Transport Panel—Rear View

MAINTENANCE

Adjustments

Air and Vacuum Relief Valves. Check and adjust the air and vacuum relief valves [figs. TTP-2 and AP-2 (UNIT 509)] as follows:

1. Install a tape; correct pressure adjustments can not be made unless a tape is threaded correctly on the tape transport panel.

2. Check the readings on the air pressure and vacuum gauges, located on the rear of the tape transport panel, before running as part of the system. The air pressure gauge, which is calibrated in pounds-per-square inch; should read between 3.5 and 4.5. The vacuum gauge, which is calibrated in inches of mercury, should read between 4.5 and 5.5. If these readings are not obtained refer to steps 3 (vacuum adjustment) and 4 (air pressure adjustment).

> *CAUTION: Do not operate the pump for a period in excess of 3 minutes if the reading on either the vacuum or air pressure gauge is over 10. The carbon vanes depend on air blown through the pump for cooling. A pressure of 10 or a vacuum of 10 indicates the flow of air through the pump is getting dangerously low. Permanent damage to the carbon vanes will result if they are overheated.*

3. To adjust the vacuum relief valve loosen the knurled jam-nut on the threaded valve-stem. Insert a screwdriver in the slotted-end and hold it to prevent rotation, and turn the second knurled nut to change the spring pressure on the valve. Remove the screwdriver and read the vacuum gauges (do not touch the valve-stem while reading the gauge or the reading may be erroneous). Repeat the adjustment until the correct reading is obtained (4.5 to 5.5). Then lock the adjustment nut with the knurled jam-nut.

4. To adjust the air pressure relief valve, loosen the hex type jam-nut and change the valve spring pressure by turning the knurled adjusting screw. When correct air pressure is obtained (3.5 +0 4.5) lock the adjusting screw with the hex jam-nut.

> NOTE: When making pressure adjustments always ascertain that all portions of the air and vacuum systems are in place and there are no leaks in the lines.

Tension Arm. The two tape tension arms (fig. TTP-1) are to be adjusted so that the spring holds the arm against the stop with a minimum spring force (3 to 4 ounces as measured with a spring scale attached to the tape arm post). To adjust the tape arm tension proceed as follows:

1. Use a length of string or tape to attach the spring scale to the tape arm post.

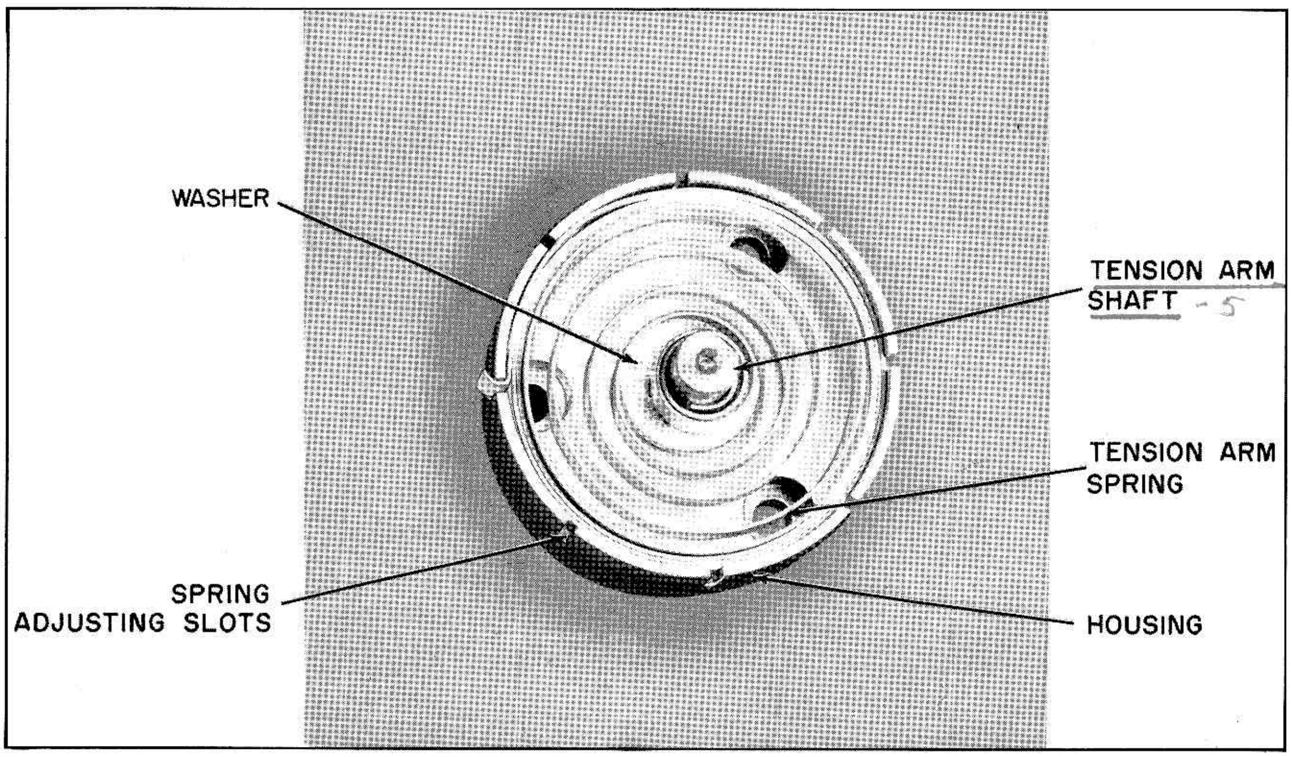

Figure TTP-3. Brake Band Tension-ARM Spring

2. Lift the arm away from the stop, making certain that the scale is at right angle to the tension arm, and note the reading on the scale. It should be between 3 and 4 ounces. If this reading is not obtained, adjust the arm tension by inserting the end of the spring (located on the back of the tape transport panel) into a different slot on the slotted rim of the housing (fig. TTP-3).

NOTE: The lower tension arm operates the tape breakage switch, and therefore any change in the position of the spring arm will require an adjustment of the tape breakage switch (S1).

Pinch Roller. Insufficient roller pressure may result in audio flutter and improper tracking near the end of a reel of tape. In the play and record modes a minimum pressure of 10 pounds is needed to lift the roller from the capstan. To adjust the pinch roller proceed as follows:

1. Remove the tape from the recorder.

2. Tie the lower tension arm back to keep the brake switch from operating, and place the recorder in the PLAY mode.

3. Using a small length of string or tape attach a spring scale to the pinch roller arm (fig. TTP-4) at the clamp screw between the two rollers, and pull at a right angle to the arm until the rollers lift off the capstan. (Turn the rollers with light finger pressure to determine when the rollers lift off.)

4. The spring scale should indicate between 9½ and 10½ pounds of pressure; if not, move the two nuts on the spring coupled solenoid link, on the rear of the tape transport panel (fig. TTP-4).

5. Tighten the two solenoid nuts after the adjustment is complete.

6. Check the position of the roll pin in the upper end of the spring coupled solenoid arm link. When the pinch roller is energized, the roll pin should be approximately centered in the clearance hole (fig. TTP-4). If not, loosen the four socket-head screws that hold the solenoid bracket, and adjust the solenoid bracket until the roll pin is centered. After the pin is centered retighten the four socket-head screws.

Reel Motor Voltage (Upper Reel). With the tape recorder in the play mode the upper reel motor will run in a clockwise direction. The motor voltage is adjusted as follows:

1. Wrap a short length of old tape around the hub of an empty reel and attach a spring scale to the end.

2. Adjust resistor, R11, located in the upper left-hand corner of the relay bank, until the motor produces 10 ounces of pull as measured on the spring scale. The voltage, as measured at terminal board TB1-2 and TB1-3 (at rear of motor, fig. TTP-16) should be approximately 45 volts.

Reel Motor Voltage (Lower Reel). With the tape recorder in the play mode, the lower reel motor will run in a counterclockwise direction. The motor voltage is adjusted as follows:

1. Wrap a short length of old tape around the hub of an empty reel and attach a spring scale to the end.

2. Adjust resistor R12, located in the upper left-hand corner of the relay bank, until the motor produces 20 ounces of pull as measured on the spring scale. The voltage as measured at terminal board TB2-2 and TB2-3 (at the rear of motor, fig. TTP-16) should be approximately 65 volts.

Motor Voltage in Wind Mode. The FORWARD-REVERSE control (variable transformer T1) located on the control panel provides the necessary voltages for the upper and lower reel motors for winding the tape. (Refer to the instruction book covering the Control Panel and Control Relay Bank, unit 305.) The limits of these voltages are established by adjustable stops located on the back frame of the wind control transformer. Access to these stops may be gained at the rear of rack 3 by swinging the relay bank assembly outward. The following procedure should be used to adjust the stops.

1. Thread a full 14-inch (1½ hours) reel of tape on the Tape Transport Panel.

NOTE: A 12½ inch (1 hour) reel may be used if the larger reel is not available, but it may be necessary to readjust the stops if the larger reel is used.

2. Press the control panel WIND button.

3. Turn the FORWARD-REVERSE control to the FORWARD position, and wind 30 seconds of tape onto the lower reel.

4. Turn the FORWARD-REVERSE control toward REVERSE, until the tape just begins to rewind, and press the control panel STOP button.

5. Remove the plug labeled AC IN (P32) on the rear of the control panel chassis.

6. Adjust the upper stop assembly so that the sliding arm of the variac cannot move further in the reverse direction.

7. Wind all but a few hundred feet of tape onto the lower reel.

8. Repeat steps 2 through 6 but using the FORWARD position of the wind control instead of REVERSE.

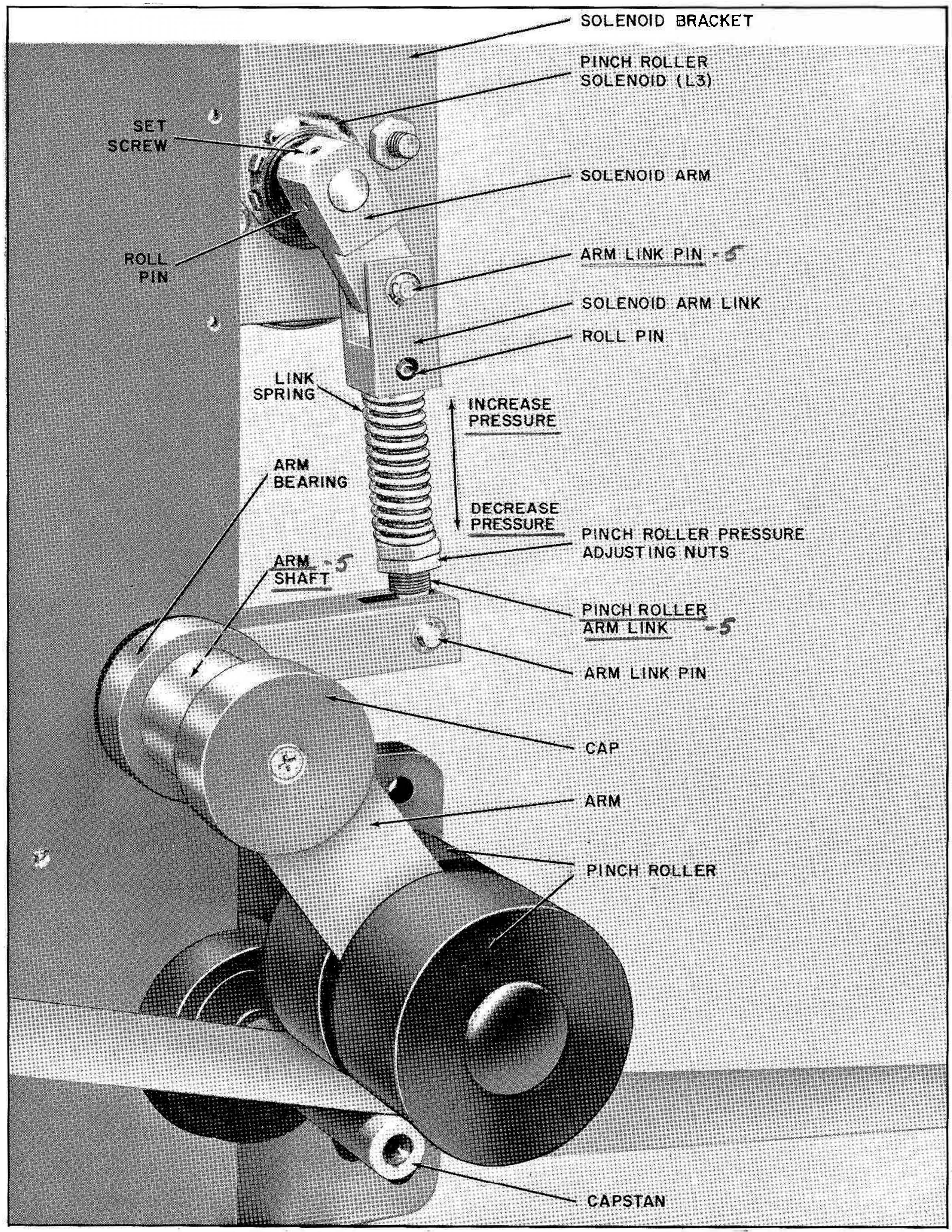

Figure TTP-4. Capstan Solenoid Linkage Assembly

TABLE OF TYPICAL MOTOR VOLTAGES

Mode	*Point of Measurement*	*Upper Motor*	*Lower Motor*
Full Reverse	Terminal Board TB1-2, 3	125	45
Full Forward	Terminal Board TB2-2, 3	45	125

Take-Up Reel Boost. The take-up reel motor must have an additional voltage applied to it in order to start it rotating when a large amount of tape is already wound on the reel. To start the lower reel motor, a voltage of 117 volts ac is applied for a short period of time. The time delay is set for two seconds at the factory but can be changed if so desired. The time delay is controlled by relay K-38 located on the auxiliary relay panel directly below transformer T2. The time delay can be increased or decreased to give the proper starting take-up action. Final Adjustment should provide a condition giving a start, using an empty reel, without any excessive jerk; also, a full reel of tape should start without throwing an excessive loop of tape.

Brake (Upper). Adjust the upper brake as follows:

1. Place an empty tape reel on the supply reel hub.

2. Wrap a length of tape or cord around the center of the empty tape reel hub so that the free end comes off to the top left. Connect a spring scale (having a capacity of at least 7 pounds) to the free end of the tape.

3. Pull the scale to the left, so that the reel will turn in a counterclockwise direction, and note the steady state reading. If the scale does not read 7 pounds adjust the spring screw (figs. TTP-5 and TTP-8), mounted near the brake solenoid on the back of the tape transport panel, for the desired reading. Make certain that the lock nut is tight after adjusting.

Brake (Lower). Adjust the lower brake as follows:

1. Place an empty tape reel on the take-up reel hub.

2. Wrap a length of tape or cord around the center of the empty tape reel hub so that the free end comes off the top right. Connect the spring scale to the free end of the tape.

3. Pull the scale to the right, so that the reel will turn in a clockwise direction, and note the steady state reading. If the scale does not indicate 7 pounds adjust the spring screw (figs. TTP-5 and TTP-8) as given in step 3 of Upper Brake adjustment.

Vacuum Guide Lead Screw Protrusion. With the control panel GUIDE POSITION switch in the MANUAL position, and the GUIDE POSITION control set to zero measure the distance between the rounded-end of the lead screw and the opposite side of the headwheel panel rectangular cutout (on the tape transport panel). This distance should be 4.75 inches; if this measurement is not obtained follow the procedures as outlined in the following paragraph.

Coarse and vernier adjustments are available for aiding in setting the lead screw for zero position of the manual control. The coarse adjustment is accomplished by removing the two socket-head screws holding the split-nut (figs. TTP-11 and TTP-12) to the positioner casting, and then rotating the nut one or more full turns with respect to the lead screw. Each turn changes the screw protrusion by 1/24 of an inch which is approximately 6/10 of one division on the manual control scale and represents the movement of the vacuum guide in thousandths of an inch. The fine or vernier adjustment is accomplished by rotating the potentiometer with respect to its mount. To free the potentiometer for making this adjustment loosen the three screws holding the clamping ring. A full turn of the potentiometer is equivalent to slightly more than one revolution of the split nut.

Vacuum Guide Lead Screw Backlash. Screw backlash is controlled by the split-nut (figs. TTP-11 and TTP-12). To adjust turn the adjusting screw in the split nut. Access to this screw is gained by removing the headwheel panel. Optimum adjustment will have the nut as tight as possible without causing sticking or binding to occur. Be sure that the lead screw and split nut are lubricated before adjusting.

Vacuum Guide Motor Gears. The amount of backlash between gears is not critical. However, the best accuracy of the manual control, backlash should be kept within reasonable limits. One of the gears is mounted directly on the output shaft of the motor (fig. TTP-11). Adjustment is accomplished by adjusting the motor location. The motor to potentiometer coupling will compensate for any shaft misalignment caused by this adjustment. After making the adjustment, rotate the gears through one complete revolution to make sure that the gears do not bind.

Vacuum Guide Friction Damper. This adjustment is not normally required. To remove the friction damper (fig. TTP-11) from the system, tighten the locknut until it is flush with the screw.

NOTE: The friction damper is eliminated on tape recorders having serial numbers 1401 and up.

Cleaning

Air Guides. With a normal air pressure of 3.5 to 4.5 pounds-per-square inch there should be air escaping from all of the air holes on the three air guides (fig. TTP-1). To insure the free flow of air the holes

should be cleaned weekly with the tool supplied (item 15 of accessory kit MI-40769). To clean the air holes proceed as follows:

1. Remove the tape from the tape transport panel.

2. Tie the lower tension arm back to keep the brake switch from operating, and place the recorder in the PLAY mode.

3. Insert the narrow-end of the cleaning tool into the air holes. The cleaning tool loosens the dirt and dust, and it is blown out through the holes when the tool is removed.

Air and Vacuum Relief Valves. These two relief valves (see fig. TTP-2 and fig. AP-2, unit 509) should be removed, disassembled, and cleaned with a solvent such as Chlorothene or Freon TF at least once every six months. After cleaning, reassemble and install the valves in their proper location. Adjust the relief valves as outlined under Adjustments page TTP-4.

Air Filter and Muffler

With the air pump (unit 509) stopped, remove the filter and muffler jars (fig. TTP-2) and empty out the entrapped solids. Remove the filter elements and wash them in a solvent such as Freon TF, alcohol, or Chlorothene. When the filter elements are clean and dry replace them carefully.

Lubrication

Certain components of the tape transport panel have to be lubricated periodically. The lubricants to be used are MI-40769-5 (oil) stock No. 219749 and MI-40769-6 (grease) stock No. 204085; these components are listed in the following table.

Part Replacement Procedure

Reel Motor Assembly. The reel motor is supplied with the reel hub pinned in place (including spider with pawls attached), and with sufficient shims to meet the 0.604 $\pm$0.010 inch dimension as shown in figure TTP-6. To remove the reel motor assembly proceed as follows:

1. Cover the units in the base of rack #2, below the reel motors, to protect them from any foreign particles that may happen to fall upon them while removing the motor assembly.

2. Disconnect the motor wires from the terminal board, located on the back of the brake assembly, and label them.

3. Remove the two bottom motor screws (use a 7/32" hex socket wrench) holding the motor to the tape transport panel.

> *CAUTION: Care must be exercised in removing the two bottom screws. If the wrench slips, the glass air-dash pot may be broken.*

4. Support the weight of the reel motor with one hand, and remove the two top motor screws.

5. Remove the complete reel-motor assembly by withdrawing the hub through the tape transport panel.

6. Install the new reel motor assembly by reversing the above procedure. When installing the new assembly use the shims supplied to obtain the 0.604 inch dimension as shown in figure TTP-6.

Component	*Fig. No.*	*Lubricant*	*How Often*
Slot in brake lever	TTP-8	MI-40769-6	6 Months
Slot in hub pawls	TTP-7	MI-40769-6	6 Months
*Hub Knob—(internally threaded bushing and threaded shaft). Remove hub knob as outlined under Pawl and Spider Assembly on page TTP-10.	TTP-7	MI-40769-6	6 Months
Tension arm shaft (from front of panel and under washer from rear of panel)	TTP-3	MI-40769-5	6 Months
Pinch Roller Arm Shaft (from rear of panel)	TTP-4	MI-40769-5	6 Months
Pinch Roller Arm Link Pins (two)	TTP-4	MI-40769-5	6 Months
**Vacuum Guide Positioner Motor	TTP-11	MI-40769-5	Monthly
Vacuum Guide Positioner Lead Screw and Split Nut	TTP-11	MI-40769-6	Monthly
Vacuum Guide Lead Screw Bearing	TTP-11	MI-40769-5	Monthly
Reel Motor Shaft and (under hub knob). Remove the hub knob as outlined under Pawl and Spider Assembly page TTP-10.	TTP-7	MI-40769-5	Monthly
Counter—(Remove counter as outlined under Counter Replacement page TTP-12.)	TTP-9		
a. Worm wheel	TTP-9	MI-40769-6	6 Months
b. Spur gear	TTP-9	MI-40769-6	6 Months
c. Drive shaft (both ends)	TTP-9	MI-40769-5	6 Months
d. Reset shaft (both ends)	TTP-9	MI-40769-5	6 Months

* Keep oil and grease off the brake washer and the surface it contacts on the hub knob.

** Apply four drops of lubricant to each section of the motor; it is only necessary to apply oil to one hole of each motor section. If excess seepage occurs, reduce the quantity of oil.

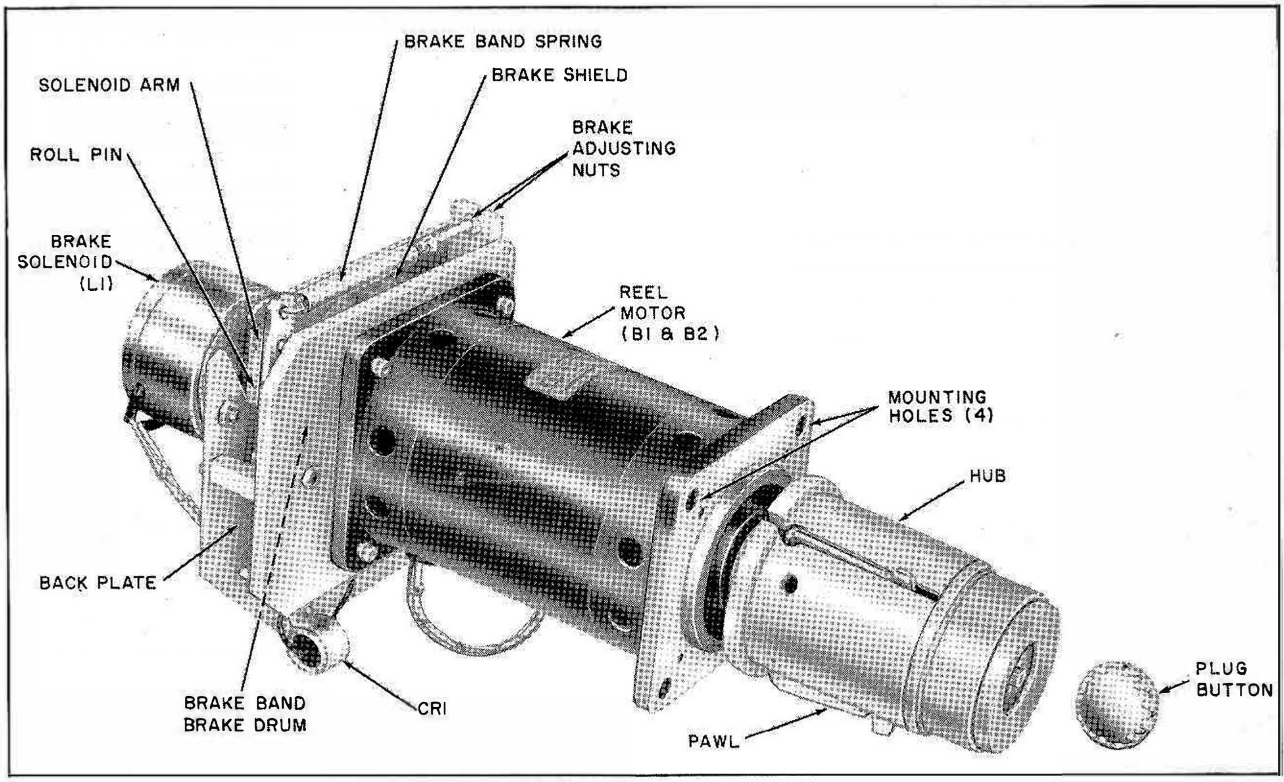

Figure TTP-5. Lower Reel Motor and Brake Assembly (Take-up Reel)

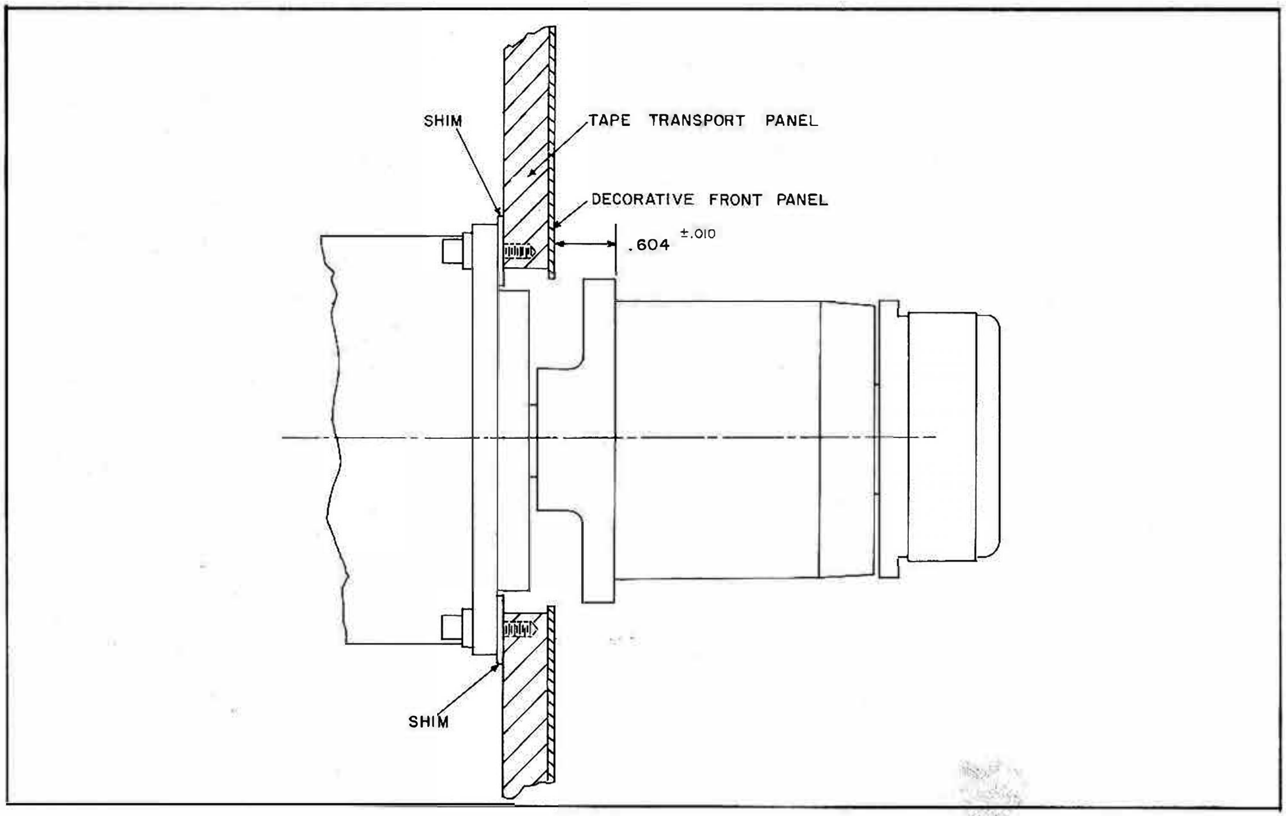

Figure TTP-6. Reel Motor and Hub Mounted on the Tape Transport Panel

Pawl and Spider Assembly. The pawl and spider assembly (fig. TTP-7) consists of the three pawls connected to a spider and three loose roll pins for connecting it to the hub. To disassemble the hub proceed as follows:

1. Remove the plug button by inserting a small screwdriver blade between the plug button and the inner rim of the hub, and prying it off.

2. Remove the brake washer assembly by extracting the socket-head screw in the center of the hub.

CAUTION: Do not lose the lockwasher behind the brake washer assembly.

3. Remove the hub knob by turning it in a clockwise direction.

4. The threaded shaft may be removed from the hub knob, if desired, by extracting the four flat-head screws.

5. Remove the three 0.094 inch diameter roll pins which hold the pawls to the spider. To do this it is necessary to drive out the roll pin with a drift pin having a diameter of 5/64 or 1/16 of an inch.

CAUTION: When removing the roll pins care must be exercised to prevent breaking of the hub shell, and most important do not submit the motor shaft to excessive shock as it may cause the shaft to bend.

6. Remove the retaining ring on the motor shaft. To remove the ring use a pair of retaining ring pliers such as "Waldes Tru-arc" pliers #2 size. When the retaining ring is removed the pawl and spider assembly and the internally threaded bushing will slip out of the hub.

7. Assemble the new pawl and spider assembly to the internally threaded bushing using the shoulder screws and rubber washers, and assemble it to the hub and motor shaft.

8. Replace the retaining ring on the motor shaft.

9. Insert the roll pins, removed in step 5, through the hole in the pawl and hub. Observe the caution note below step 5, when pressing in the pins.

10. Replace the threaded shaft if it was removed in step 4.

11. Replace the hub knob and, turn it in a counterclockwise direction.

12. Replace the lock washer, brake washer, and socket-head screw that was removed in step 2. (The lock washer goes between the brake washer and the end of the shaft.)

13. Replace the plug button that was removed in step 1.

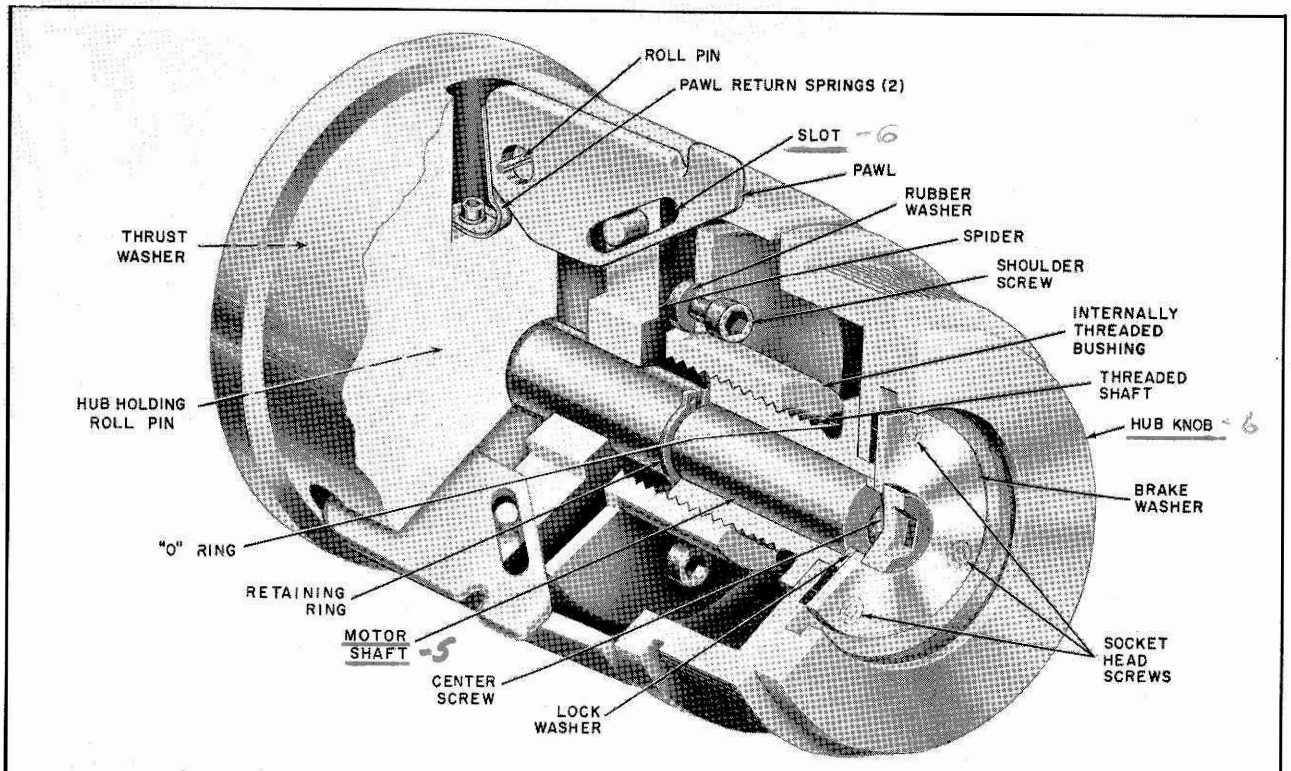

Figure TTP-7. Reel Hub Assembly

Brake Band. When replacing a worn or defective brake band (fig. TTP-8) be sure the correct replacement is installed. (The top brake band is stock number 218675 and the bottom brake band is stock number 218674.) To replace the brake band proceed as follows:

1. Remove the back plate by removing the six 1½ inch long cross-recessed screws.

2. Remove the "c" washer from the center of the pin holding the brake band to the lever arm, and then remove the pin.

3. Remove the two socket-head screws, flat washers, and lockwashers that hold the end of the brake band and then lift out the brake band.

NOTE: The circular brake shield may be lifted off to facilitate removal.

4. Install the new brake band.

5. Replace the pin and "c" washer holding one end of the brake band to the lever arm.

6. Replace the circular brake shield on its pins.

7. Replace the two screws and washers that were removed in step 3.

8. Adjust the brake band. To adjust the brake band apply 24 volts dc to the brake solenoid by connecting TB1-5 or TB2-5 to ground (depending upon which brake lining is being replaced). Adjust the end of the brake band with the slotted holes, so that, the band rides out against the circular shield and does not touch the brake drum at any point. To determine this rotate the shaft; the shaft should rotate and coast to a free stop. Tighten the screws holding the brake band, and remove the ground connection when the adjustment is complete.

9. Replace the back plate that was removed in step 1.

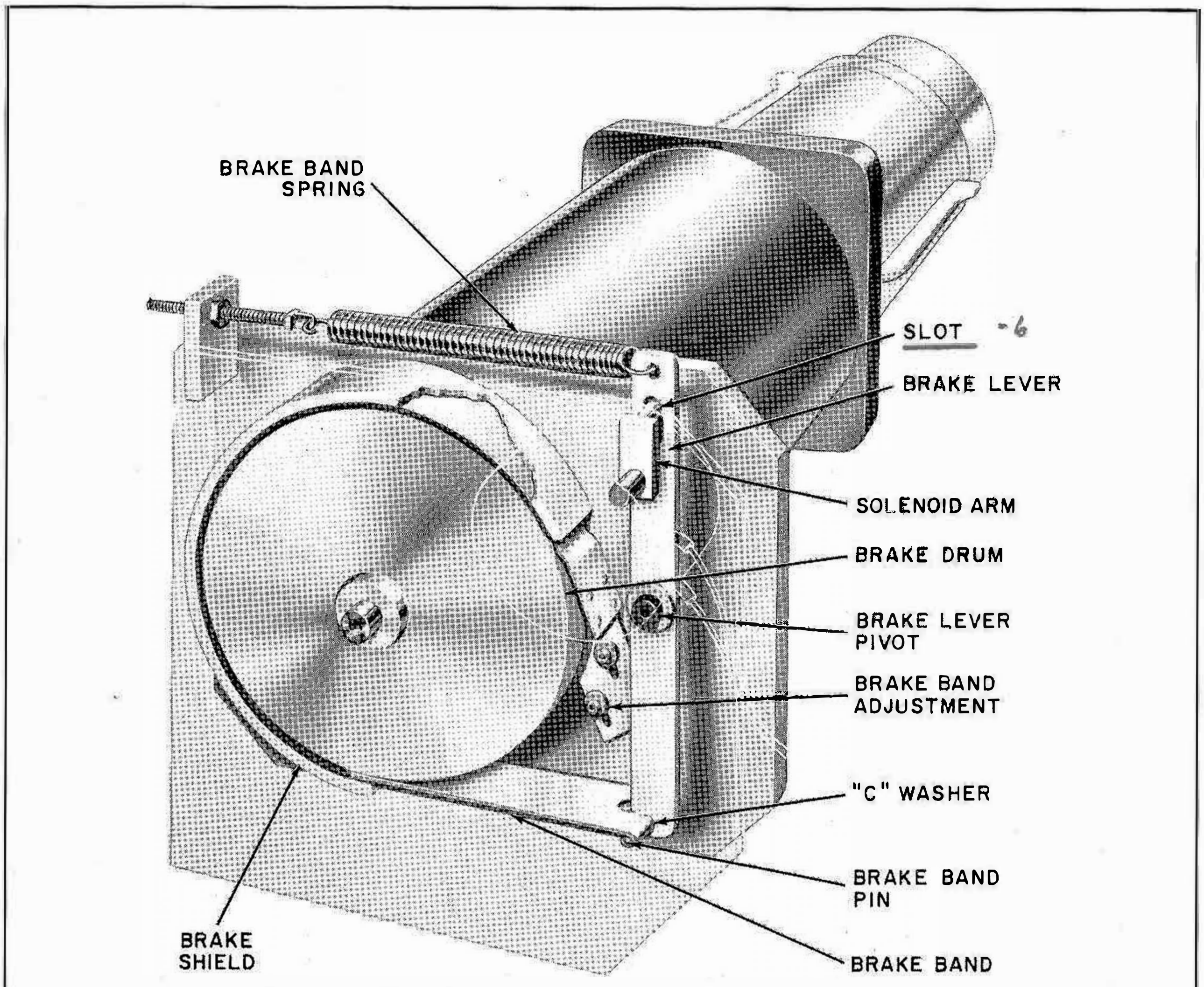

Figure TTP-8. Cut Away View of Reel Motor Showing the Brake Band

Brake Solenoid (L1 and L2). To replace either brake solenoid (fig. TTP-2) proceed as follows:

1. Remove the leads of the defective solenoid from its appropriate terminal board (TB2 for L1 and TB1 for L2).

2. Note the orientation of the arm (figs. TTP-5 and TTP-8) on the defective solenoid.

NOTE: The replacement solenoid is supplied less arm and roll pin.

3. Remove the arm from the defective solenoid by driving the roll pin out of the hole with a drift pin.

4. Place the arm assembly on the shaft of the replacement solenoid in the same position it occupied on the old solenoid. When the hole in the solenoid shaft is aligned with the hole in the arm assembly slightly tighten the set screw, in the end of the arm assembly, sufficiently to hold the parts in alignment.

5. Support the underside of the arm assembly and gently tap the spring pin through the aligned holes until the spring pin is flush with both sides of the arm. Tighten the set screw securely.

6. Mount the new solenoid on the back plate and secure it with the two hex-nuts and lockwashers that were removed in step 3.

7. Connect the solenoid wires to the terminal board (refer to figure TTP-16).

8. Adjust the brake lining as described under "Brake Band," page TTP-11.

9. Adjust the braking force as described under "Brake Adjustment," page TTP-7.

Air Dash-Pot (Upper and Lower Tension Arms). To replace the air dash-pots on the tension arms proceed as follows:

1. Remove the screw holding the plunger wire to the connecting link.

2. Remove the two socket-head screws holding the air dash-pot and bracket to the rear of the tap transport panel, and remove the assembly.

3. Remove the air dash-pot from its bracket by removing the four socket-head screws, lock washers, and nuts.

4. Connect the new air dash-pot to the bracket using the four screws, lock washers, and nuts that were removed in step 3.

5. Check the adjustment of the air dash-pot by pulling on the plunger wire. With the plunger at the bottom of the cylinder some resistance to the pulling should be felt. If no resistance is felt, turn the center screw in a clockwise direction (while looking down on the screw) at the same time checking the dampening effect on the plunger (maximum dampening is the usual setting).

6. Remount the air dash-pot bracket on the tape transport panel using the socket-head screws that were removed in step 2.

7. Replace the screw and washer that holds the plunger wire to the connecting link, that was removed in step 1, but thread the screw only enough to hold it in the hole. The tension arm should be at rest against its stop, on the front of the tape transport panel, when no tape is threaded. Bend the plunger wire around the screw (as it was on the original dash-pot) at a point which holds the plunger 1/32 of an inch from the bottom of the cylinder. Tighten the screw on the plunger wire.

Vacuum Guide Dash-Pot. To replace the air dash-pot (fig. TTP-12) on the vacuum guide solenoid (L4) proceed as follows:

1. Remove the headwheel panel.

2. Remove the screw, flat washer, and lockwasher holding the plunger wire to the connecting link on the solenoid. (This may be done through the headwheel panel opening.)

3. Remove the two socket head screws, located on the rear of the tape transport panel, holding the dash-pot bracket assembly to the mounting plate of solenoid L4, and remove the assembly.

4. Replace the defective dash-pot on the bracket.

5. Check the adjustment of the dash-pot by pulling on the plunger wire. With the plunger at the bottom of the cylinder some resistance to the pulling should be felt. If no resistance is felt, turn the center screw in a clockwise direction (while looking down on the screw) at the same time checking the dampening effect on the plunger (maximum dampening is the usual setting).

6. Remount the bracket assembly on the solenoid mounting plate.

7. Replace the screw and washer that holds the plunger wire to the connecting link, that was removed in step 2, but thread the screw only enough to hold it in the hole. Bend the plunger wire around the screw, as it was on the defective dash pot, at a point which holds the plunger 1/32 of an inch from the bottom of the cylinder when the solenoid is not energized. When this adjustment has been made, tighten the screw on the plunger wire.

Counter. To replace a defective counter or make repairs on the counter proceed as follows:

1. From the rear of rack #2, (fig. TTP-2), remove the four socket-head screws passing through the tape transport panel which hold the counter cover in place.

2. Slide the indicator lamp out of its recess.

3. Remove the four socket-head screws holding the counter assembly (fig. TTP-9) to the tape transport panel, and remove the counter assembly.

4. The counter may be replaced by removing the four socket-head screws holding it to the casting, transfer the knob, gear, and light shield to the new counter.

5. Connect the new counter assembly to the casting with the four socket-head screws that were removed in step 4.

6. Replace the counter assembly on the rear of the tape transport panel, using the four socket head screws that were removed in step 3, and adjust its position so that the worm and worm wheel mesh without binding.

7. Replace the indicator lamp in its recess.

8. Replace the counter cover using the four socket head screws that were removed in step 1.

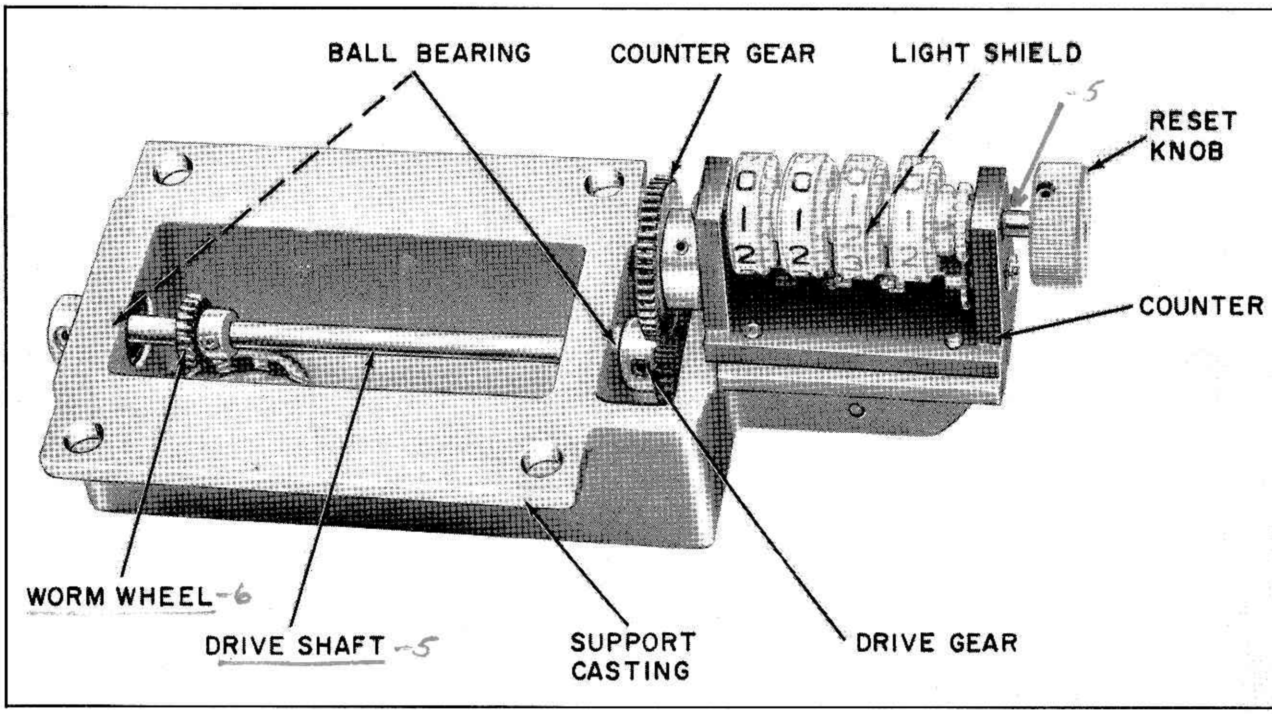

Figure TTP-9. Counter Assembly

Counting Capstan Roller. To remove the counting capstan roller proceed as follows:

1. Remove the counter assembly from the rear of the tape transport panel as outlined under "Counter".

NOTE: The counter assembly must be removed in order to gain access to the three socket-head screws holding the roller.

2. Remove the three socket-head screws holding the counting capstan roller to the tape transport panel.

3. Install the new roller, and reassemble by reversing steps 1 and 2 above.

Bearing (Counting Capstan Roller). To replace the bearings in the counting capstan roller proceed as follows:

1. Remove the counter roller as outlined in steps 1 and 2 under "Counter".

2. Loosen the roller front cover by removing the three flat-head screws.

3. Remove the worm gear, on the end of the shaft, by extracting the 5/64 inch diameter roll pin. Support the shaft assembly to prevent damage to the worm gear or shaft, and use a 1/16 inch diameter drift pin to drive out the roll pin.

4. Remove the worm gear. After removal of the worm gear the cover and shaft may be withdrawn through the bearing. The small bearing may be extracted by removing the small-internal-retaining ring in the base of the support and pressing out the bearing. To extract the large bearing remove the small

external retaining ring on the support. Remove the roller from the support exposing the bearings and press out the bearings.

NOTE: To facilitate the removal of the inner bearing the bottom plate should be removed.

5. Press the large bearings into the roller until they touch the large internal retaining rings, and replace the bottom plate.

6. Assemble the roller to the support, and replace the small external retaining ring to hold the roller in place.

7. Insert the cover and shaft through the center hole of the support, and replace the small bearings and small internal retaining ring.

8. Connect the worm gear to the shaft using the roll pin removed in step 3. After assembly, the counting capstan roller should turn freely. (Application of 0.07 inch ounces of torque should cause the unit to turn.)

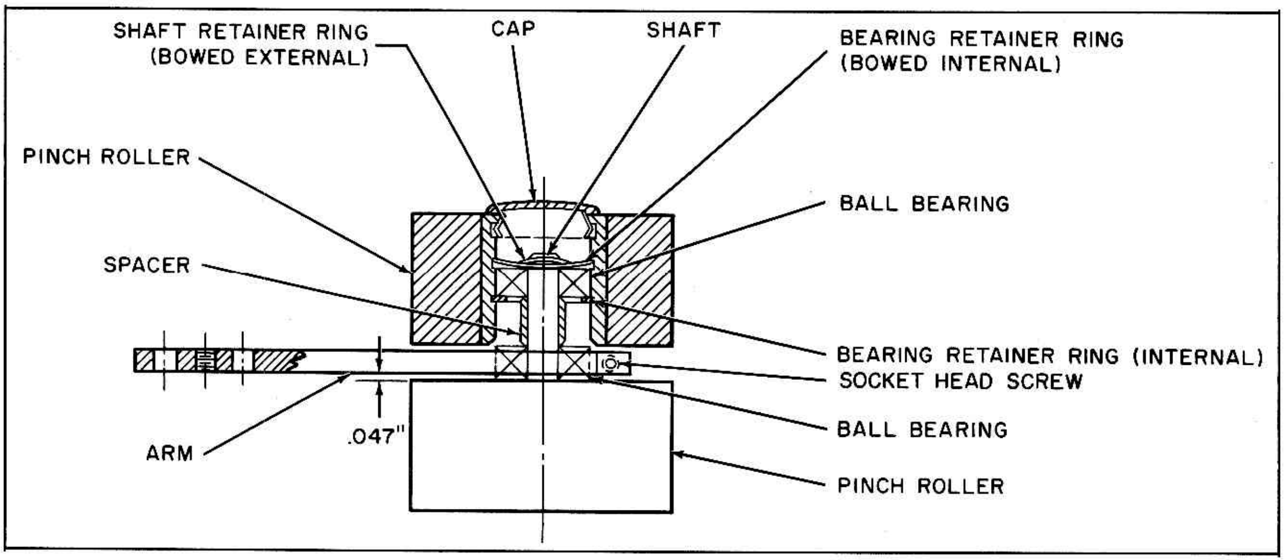

Figure TTP-10. [redacted] ***Capstan Pinch Roller*** [redacted]

Capstan Motor. Te replace the capstan motor proceed as follows:

1. Remove the motor wires from terminal board TB3 (terminals 1, 2, and 3).

2. Remove the four socket-head screws holding the capstan motor to the rear of the tape transport panel.

NOTE: Support the motor when removing the last two screws to prevent it from falling and bending the motor shaft or damaging the audio compartment below.

3. Install the new motor and replace the four socket-head screws that were removed in step 2.

4. Connect the motor wires to terminal board TB3 (see figure TTP-16).

Bearings (Capstan Pinch Roller). To replace the bearings in the capstan pinch roller proceed as follows:

1. Remove the cover on the roller arm by extracting the cross recessed screw (fig. TTP-4) holding it.

2. Remove the three socket head screws holding the roller arm to the roller.

3. Remove the end cap (fig. TTP-10) on the outside roller by prying it off with a small screwdriver.

4. Remove the bowed external retaining ring on the shaft, and slide the roller and bearing off of the shaft.

5. Remove the bowed external retaining ring on the opposite end of the shaft and remove the inside roller.

6. Remove the internal retainer rings on each side of the bearing, and push out the bearing.

7. Insert the new bearing into the roller, and replace the internal retainer rings. Check the bearing for smooth operation.

NOTE: The bowed retainer ring is mounted on the side away from the support arm on each roller and the flat retainer ring is mounted close to the support arm.

8. Place one pinch roller on the shaft, and be sure that the spacer is in place between the arm bearing and the roller. Hold the roller in place with the bowed external retaining ring.

9. Place the arm bearing on the shaft, and insert the roller, shaft, and arm bearing through the support and clamp the arm bearing. Allow about .047 inch of clearance between the arm and roller.

> *CAUTION: When replacing the bearing in the arm do not tighten the socket-head screw too much as the bearing may become distorted in shape and bind on the shaft.*

10. Assemble the other spacer roller and retainer ring and check the entire assembly for smooth operation.

11. Replace the end caps, remount the arm to the actuating shaft, and replace the cover.

12. Check the pinch roller adjustment as outlined under "Pinch Roller Adjustments," page TTP-5.

Capstan Solenoid. To replace the capstan solenoid proceed as follows:

1. Remove the two solenoid wires from terminal board TB3 (terminals 5 and 6).

2. Loosen the two set screws holding the solenoid arm to the solenoid shaft (fig. TTP-4).

3. Remove the four socket-head screws holding the solenoid bracket to the rear of the tape transport panel, and remove the assembly.

4. Remove the roll pin, holding the arm to the solenoid shaft; by driving it out with a suitable drift pin. (Support the shaft to prevent damage to the parts.)

5. Loosen the set screw at the end of the arm, and remove the linkage assembly.

6. Remove the two hex nuts and lock washers holding the solenoid to the bracket, and remove the solenoid.

7. Install the new solenoid on the bracket assembly in the same position as the old one. (The solenoid leads should be on the right side when looking at the rear of the solenoid opposite the shaft end.) Secure the solenoid with the lockwashers and nuts removed in step 6.

8. Place the linkage assembly on the solenoid shaft and align the hole in the arm with the hole in the solenoid shaft. When the holes are aligned, slightly tighten the set screw sufficiently to hold the parts in alignment. Insert the roll pin into the aligned holes. While supporting the underside of the link tap the roll pin into the aligned holes until it is flush on both top and bottom. Tighten the set screw securely.

9. Replace the bracket assembly, and secure it with the socket-head screws that were removed in step 3.

10. Connect the pivot arm to the pivot shaft, and tighten the two set screws securely.

11. Connect the solenoid leads to terminal board TB3, refer to the schematic diagram figure TTP-16.

12. Readjust as outlined under "Pinch Roller Adjustment" on page TTP-5.

Vacuum Guide Positioner Motor. When removing or replacing the positioner motor mark the position of the motor shaft and potentiometer so that they can be kept in their correct rotational positions. To replace the motor proceed as follows (fig. TTP-11).

1. Remove the four servo motor leads from terminal board TB6 (see schematic diagram figure TTP-16).

2. Remove the two screws, located on the rear of the motor that hold the motor to the assembly frame and then remove the motor and gear assembly.

> NOTE: The nylon portion of the potentiometer to motor coupling is a loose piece and will fall out when either the potentiometer or the motor is removed.

3. Loosen the two set-screws in the large gear, and remove the gear.

4. Install the gear assembly on the new motor so that there is a 13/32 inch space between the motor and gear face. Tighten the two set screws.

5. Install the new motor in the same position, on the assembly frame, that the old one occupied; be sure that the nylon coupling insert is engaged in the proper slots. Replace and tighten the two screws that hold the motor to the frame that were removed in step 2.

> NOTE: There should be 0.015 to 0.020 of an inch axial play between the nylon insert and the collar portion of the coupling.

6. Connect the motor leads to the terminal board TB6, see figure TTP-16.

> NOTE: The cable hole on the motor should be toward the rear of the tape transport rack.

Lead Screw Shaft. To replace the lead shaft proceed as follows:

1. Loosen the two socket-head set screws in the driven gear, refer to figure TTP-11.

2. Unscrew the shaft from the split nut and withdraw it through the bearing.

3. Install the new lead screw shaft through the bearing and gear, and screw it into the split nut.

4. Roughly adjust the shaft to obtain a dimension of 0.38 of an inch between the rounded face of lead screw and the face of the split nut, refer to figure TTP-11. When this dimension is obtained the faces of the gears must be flush within 0.03 of an inch. Tighten the set screws in the gear and be sure that they engage the flats on the shaft. The wiper arm of the potentiometer should be midway in its travel within 20° (1.75 turns from the end).

5. Make the final adjustment as outlined under "Lead Screw Protrusion," page TTP-7.

Vacuum Guide Potentiometer. To replace the 3½ turn vacuum guide potentiometer proceed as follows:

1. Remove the complete vacuum guide motor assembly (fig. TTP-11) by removing the four socket-head screws holding it to the tape transport panel. If necessary remove the wires going to terminal board TB6-6.

2. Unsolder the three potentiometer leads.

3. Remove the three screws holding the retainer collar, and then remove the collar and potentiometer.

CAUTION: When removing the potentiometer be careful not to lose the nylon coupling insert.

4. Remove the coupling from the defective potentiometer by loosening the two set screws.

5. Install the coupling bushing on the shaft of the replacement potentiometer, and tighten the set screws.

6. Install the replacement potentiometer with the nylon insert in place.

7. Install the retaining collar, and tighten it slightly.

NOTE: There should be 0.015 to 0.020 of an inch axial play between the nylon insert and the coupling bushing when it is installed in the assembly.

8. Connect the three leads of the potentiometer to terminal board TB6, refer to figure TTP-16.

9. Roughly adjust the potentiometer and lead screw as outlined under step 4 of "Lead Screw Shaft," page TTP-16.

10. Mount the assembly on the tape transport panel and adjust as outlined under "Adjustments" page TTP-7.

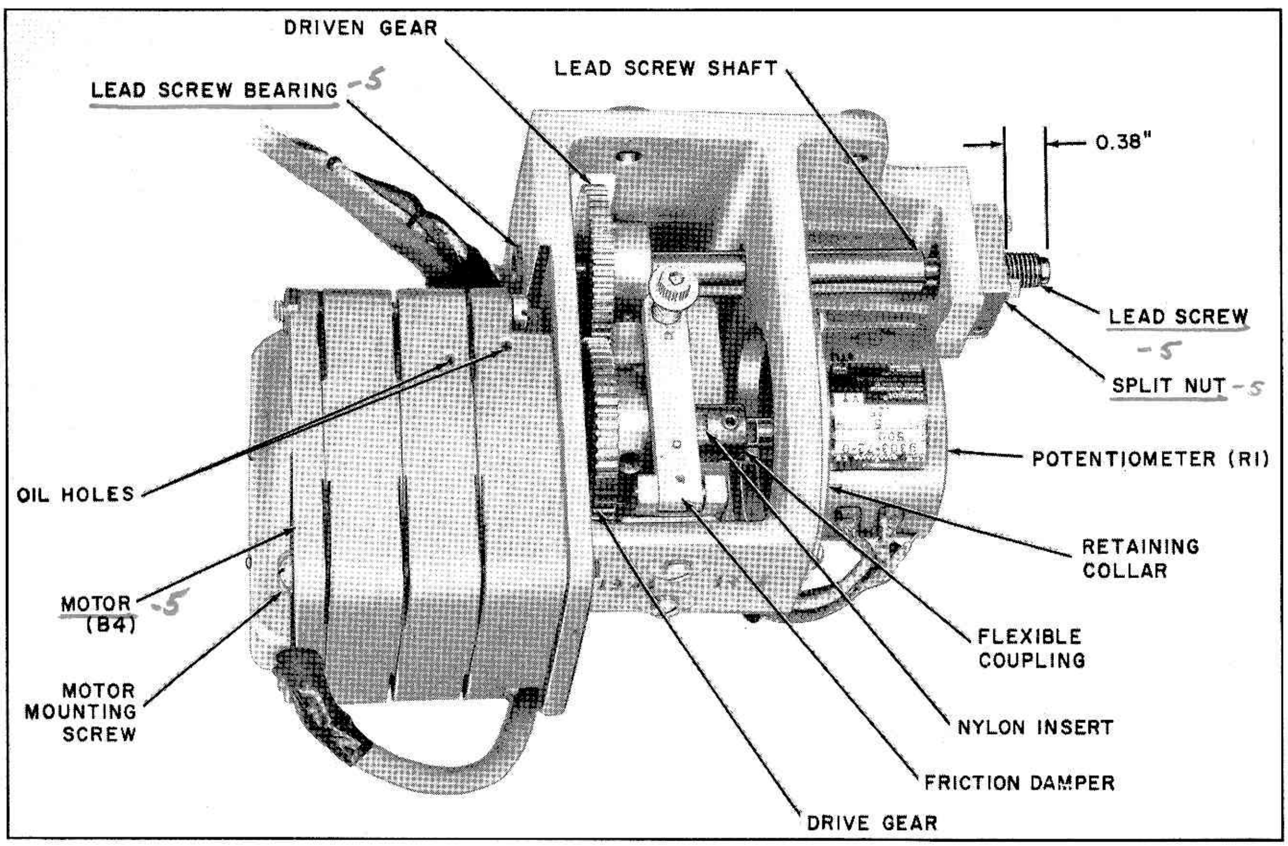

Figure TTP-11. Vacuum Guide Positioner

Vacuum Guide Solenoid (L4). To replace the vacuum guide solenoid (figs. TTP-2 and TTP-12) proceed as follows:

1. Remove the headwheel Panel.

2. Remove the socket-head screw holding the air dash-pot link to the solenoid armature plate, and disassemble the lockwasher, flat washer, link bushing, and spacer washer.

3. Remove the two solenoid wires from terminal TB7 (terminals 3 and 4).

4. Scribe a circle to mark the position of the solenoid case on the mounting bracket as accurately as possible so that the new solenoid can be located in the exact same position as the old solenoid. Also, note the orientation of the solenoid leads coming out of the case; they should be to the left when looking through the headwheel panel opening.

5. Remove the defective solenoid and mount the new solenoid in its place. Use the proper shims (supplied) to obtain the 1.540 dimension as shown in TTP-13. This dimension can be measured by laying a straight edge across the headwheel panel opening so that it rests on the ½ inch thick tape transport panel and not on the 1/16 inch thick decorative plate, see figure TTP-14.

6. Adjust the solenoid if necessary to obtain the dimensions as shown in figure TTP-14, including the coupling slot angle of 15°, and then tighten the mounting nuts securely.

NOTE: A headwheel panel may be used as a guide to center the solenoid coupling and slot on the eccentric shaft and pin. Also if the 15° angle is incorrectly set the solenoid travel will be reduced and the full 0.005 inch of guide travel will not be possible.

7. Reassemble the dash-pot link and pivot.

NOTE: The link arm must pivot freely and the screw must not protrude through the rear of the armature plate.

8. Connect the solenoid leads to terminal board TB-7, see schematic diagram figure TTP-16.

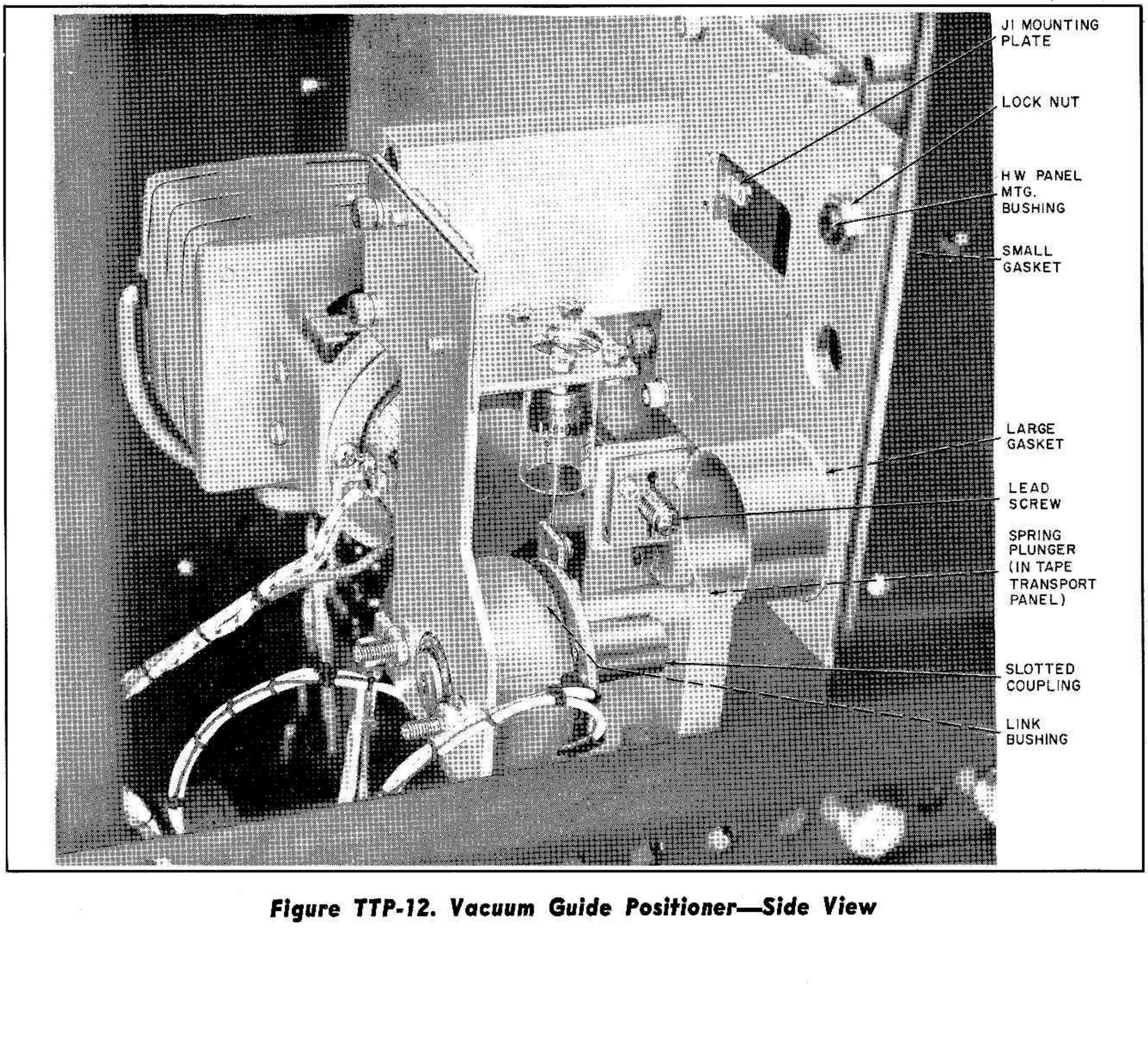

Figure TTP-12. Vacuum Guide Positioner—Side View

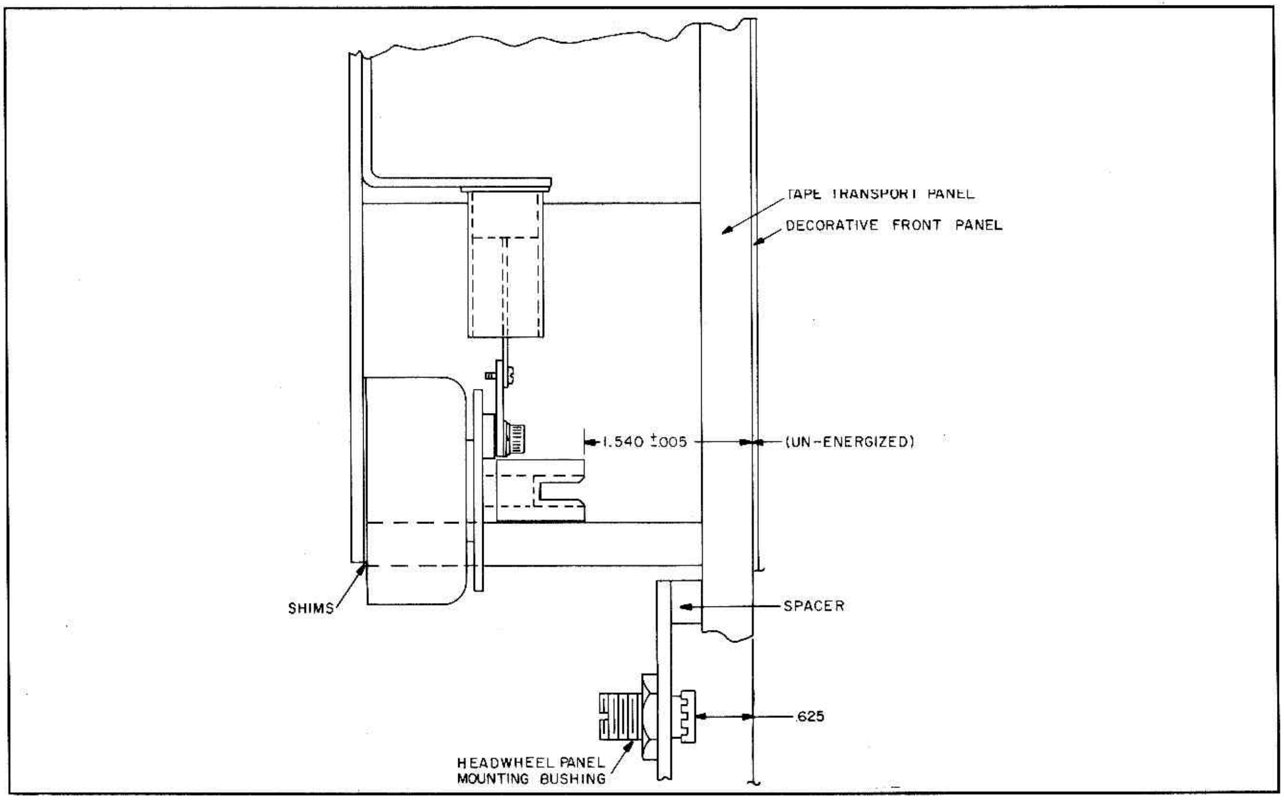

Figure TTP-13. Vacuum Guide Solenoid Mounting Dimensions

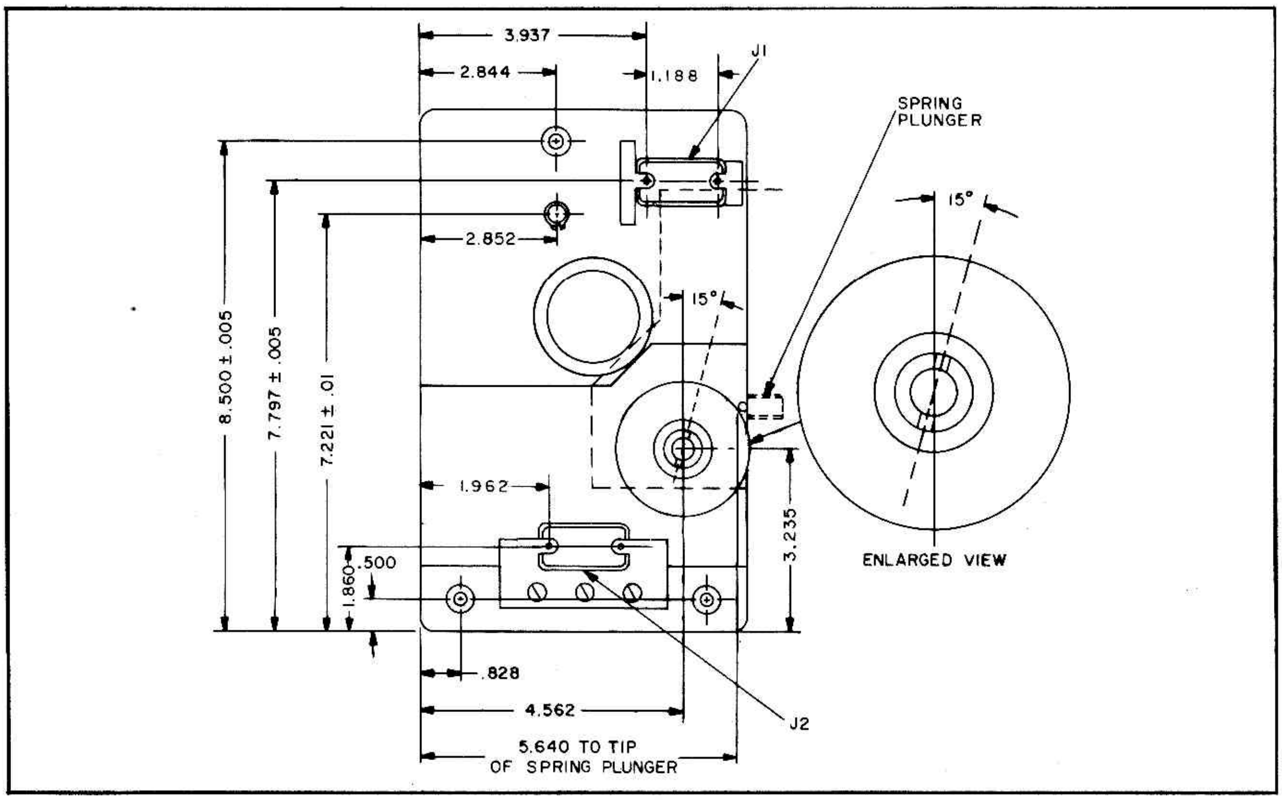

Figure TTP-14. Vacuum Guide Solenoid Mounting Dimensions

Headwheel Panel Mounting Bushings. The headwheel panel mounting bushings require accurate positioning to insure easy installation and removal of the headwheel panel. These bushings also locate the headwheel with respect to the tape (see figs. TTP-12, TTP-13, and TTP-14).

When replacing a bushing it is important that the 0.625 inch dimension as shown in figure TTP-13 be obtained. The bushing may be adjusted by loosening the lock-nut and turning the slotted end of the bushing with a screw driver. The measurement must be taken with the lock-nut tight, and may be made by laying a straight edge across the headwheel panel opening so that it rests against the ½ inch thick tape transport panel and not the 1/16 inch thick decorative plate. Measure the distance from the tape transport panel to the cap of the bushing.

If the mounting plates (upper or lower) are removed, the plates must be reorientated so that the dimensions shown in figure TTP-14 are obtained for both the headwheel panel mounting bushings and connectors.

NOTE: A headwheel panel may be used as a guide, and to check the position of the bushing.

Connectors J1 and J2. If the video pre-amplifier or the mounting plate for connector J1 are moved for any reason, the connectors J1 and J2 should be repositioned according to the dimensions given in figure TTP-13 to insure easy insertion and removable of the headwheel panel.

Audio Post Assembly (Erase, Rec/Play, and Simul.). To replace a defective audio post assembly proceed as follows:

1. Remove the dust cover on the front of the tape transport panel.

2. Remove the cover from the terminal box on the rear of the tape transport panel.

3. Disconnect the wires of the head assembly to be changed, refer to figure TTP-16.

4. Remove the four socket head screws at the base of the audio post to be changed and withdraw the leads through the panel.

> *CAUTION: Protect the surface of the heads and the highly polished support bar in the center from accidental damage while handling.*

5. Install the new audio post assembly and replace the four socket-head screws and shims (if they are used) at the base of the post assembly, refer to figure TTP-15.

NOTE: The Rec/Play and Play (Simul.) head assemblies have shims 0.005 of an inch thick under the two rear screws. These shims tilt the posts slightly to control the tape position. The top assembly (Erase) does not require these shims.

6. Connect the wires to the appropriate terminal board, refer to figure TTP-16.

7. Replace the dust cover (front) and terminal box cover (rear).

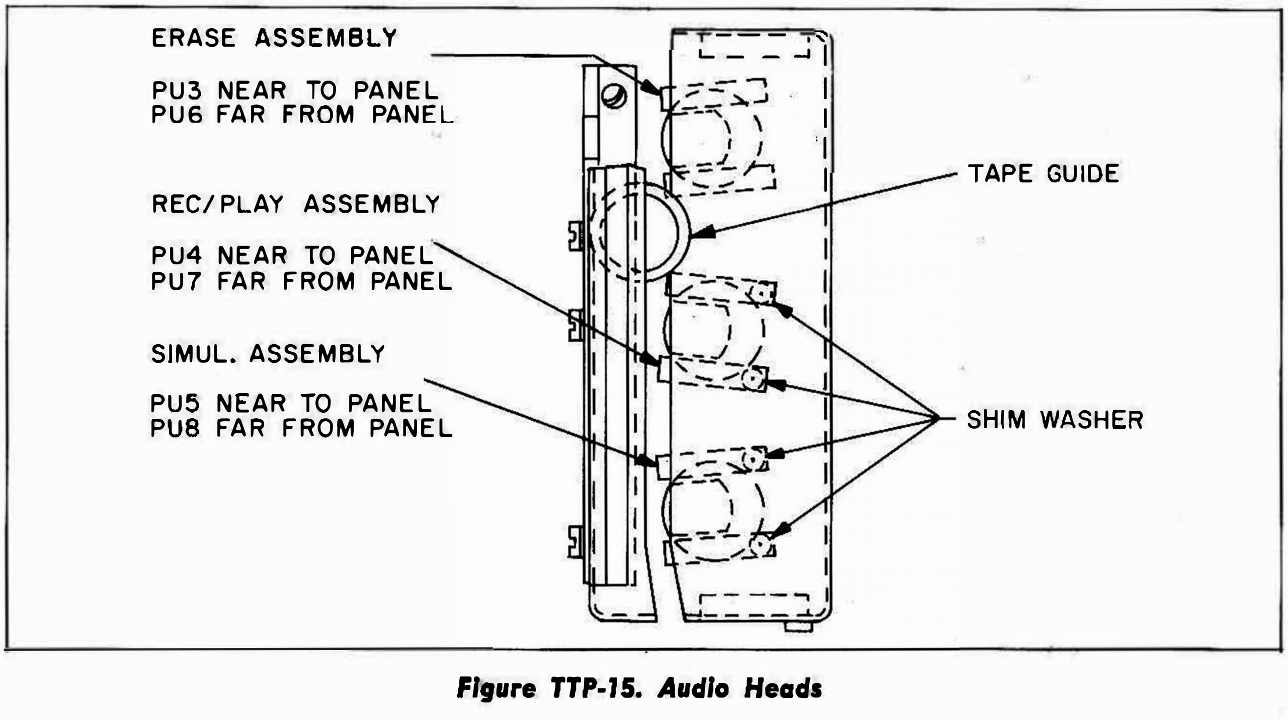

Figure TTP-15. Audio Heads

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
			Reel Motor and Brake Assembly
B1, B2	221331		Reel Motor and Hub: upper and lower (Hub includes Spider and Pawl assembly)
C1, C3	18501	990196-8	Capacitor: paper, 10 μf ±10%, 600 v
CR1, CR2	221595	8981614-123	Diode: contact protector
	218675	8721882-502	Band: brake, for top reel brake
	218674	8721882-501	Band: brake, for bottom reel brake
	218681	8439049-1	Drum: brake
	221594	990331-195	Pin: roll, hub holding
	209681	990331-147	Pin: roll, arm to solenoid L1 and L2
	206058	746017-22	Ring: rubber, "O" ring
	223859		Spider & Pawl Assembly, Reel Holding (including 3 roll pins for attaching to hub)
	218668	8439092-1	Spring: brake band lever tension
	218673	8957182-2	Spring: pawl return
L1	222092	8439045-1	Solenoid: rotary, lower brake
L2	222093	8439045-2	Solenoid: rotary, upper brake
	218672	8976584-1	Washer: thrust, hub to motor spacing
	221522	8511432-501	Washer Assembly: reel hub braking
	221523	8958293-10	Washer: shim .010 thk. (Reel Motor Shim)
	221524	8958293-11	Washer: shim, .020 thk. (Reel Motor Shim)
			Capstan Motor Assembly
B3	218537	8720037-1	Motor: capstan drive, 115 v 60 cycle
CR3	221699	8981614-130	Diode: contact protector
	218688	8439051-1	Flywheel: capstan
			Vacuum Guide Positioner Assembly
B4	218693	8435817-2	Motor: servo, vacuum guide positioner
CR4	221595	8981614-123	Diode: contact protector
L4	219771	8461486-501	Kit: guide solenoid with slotted coupling and shims
R1	218695	8441378-1	Potentometer: multi-turn: wire wound, 500 ohm ±5%
	221293	8978020-1	Coupling: slotted, vacuum guide solenoid
	221298	8980178-1	Bushing: link (solenoid L4)
	218699	8980074-1	Coupling: insulated
	217196	8951320-1	Dashpot: air
	218694	8441377-501	Gear: drive gear assembly
	218697	8980062-2	Gear: spur, driven
	218698	8980065-1	Nut: split
	218700	8980075-1	Shaft: vacuum guide positioning
			Pinch Roller and Arm Assembly
	218677	8979083-501	Arm: pinch roller solenoid
	218665	8976538-501	Bearing: pinch roller arm bearing assembly
	218541	8976566-3	Bearing: ball, pinch roller
	221296	8979719-1	Cap: pinch roller arm holding cap
	221291	8976541-1	Link: pinch roller arm link, threaded 3/8-32
	221290	8976540-1	Link: solenoid arm link
	221292	8976569-1	Pin: arm link
	255328	990331-167	Pin: roll, L3 and link assembly
	218667	8439042-501	Roller: pinch (2 req'd.)
	218666	8976534-1	Shaft: pinch roller arm shaft
L3	222094	8439017-1	Solenoid: rotary, pinch roller
	218669	8439092-2	Spring: pinch roller link spring

Symbol No.	Stock No.	Drawing No.	Description
			Roller, Tape Guide and Counter Roller Assy.
	218540	8976566-2	Bearing: ball, small
	223432	8976566-7	Bearing: ball, large
	219501	8439014-502	Roller: counter roller only
	218676	8976570-1	Shaft: roller
	203877	8976558-1	Worm: roller shaft
			Tape Tension Arm
	218687	8989698-501	Rod: tension arm
	218686	8439089-2	Shaft: tape tension arm shaft
	218696	8979011-1	Spring: tension arm
	221294	8979034-1	Stop: rubber, tension arm
	217196	8951320-1	Dashpot: air
	221295	8979038-501	Housing: power spring
			Air Pressure and Vacuum System
		8980064-1	Filter: air
	221233		Cup: glass filter cup (Pt. of 8980064-1)
	221234		Filter: filter element only (Pt. of 8980064-1)
	218381	8979052-2	Gauge: pressure
	218380	8979052-1	Gauge: vacuum
	218522		Jar: glass (for filter or muffler)
	218521		Muffler: outlet only (less glass jar)
	218837	8980148-1	Valve: pressure relief
	218372	8979709-1	Valve: vacuum relief
	218659	8979717-2	Gasket: lg. rubber, 2" O.D. x 1.5" I.D. x .38" thk.
	221698	8979717-3	Gasket: sm. rubber, 1.00" O.D. x .38" I.D. x .38" thk.
	221297	8979770-3	Tubing: "tygon" ¼"I.D. x 3/8"O.D. x 38¼" lg.
			Counter
	218540	8976566-2	Bearing: ball, counter drive shaft
	219629	8725824-1	Counter: minutes and seconds
	219502	8983841-2	Gear: counter drive
	219503	8983842-1	Gear: counter end
XDS1		480351-58	Holder: lamp
DS1		990158-12	Lamp: #47
	218663	8976559-2	Worm Wheel: counter drive shaft
			Headwheel Panel Cover Assembly
	219479	8980086-1	Spring: torsion
	219480	8441382-1	Window: plastic
			Audio and Master Erase Heads
PU1	219090	8956862-501	Head: master erase
PU2			Not Used
PU3, PU6	221878	8611628-506	Magnetic Head Post Assembly: (audio Erase) included heads PU3, PU6
PU4, PU7	221879	8611628-507	Magnetic Head Post Assembly (audio Rec/Play) includes heads PU4, PU7
PU5, PU8	221877	8611628-505	Magnetic Head Post Assembly (audio Sim Play) includes heads PU5, PU8
C11		8924416-304	Capacitor: mica, 560 $\mu\mu f$ ±5%, 500 v
T1	218922	8431148-1	Transformer: erase
	218923	8980181-1	Cap: master, erase
	95481	727537-1	Catch: spring, audio-head compartment
	221288	727537-96	Stud: latch, audio-head compartment
	221289	8958293-8	Washer: shim, for heads PU4, PU5, PU7, PU8
			Air Guides
	219498	8441334-504	Guide: air, mounted below PU1
	219499	8441334-505	Guide: air, mounted above PU1
	219500	8441334-506	Guide: air, mounted below magnetic head compartment
	218671	8438361-1	Guide: tape, mounted in magnetic head compartment

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			Miscellaneous:
	213667	8813284-1	Actuator: microswitch
	220121	8983852-501	Bushing Assembly: head wheel panel mtg.
C6, C7	18501	990196-8	Capacitor: paper, 10 μf ±10%, 600 v
C8 to C10	17047	990196-6	Capacitor: paper, 6 μf ±10%, 600 v
J1	223072	8464649-1	Connector: female, 11 contact chassis mtg.
	204085	891997-51	Grease: (2 oz. tube)
	219749	8983851-1	Oil: (1 pint)
	221299	8983850-1	Plunger: spring (HW panel)
S1	59586	460569-4	Switch: micro S.P.D.T.

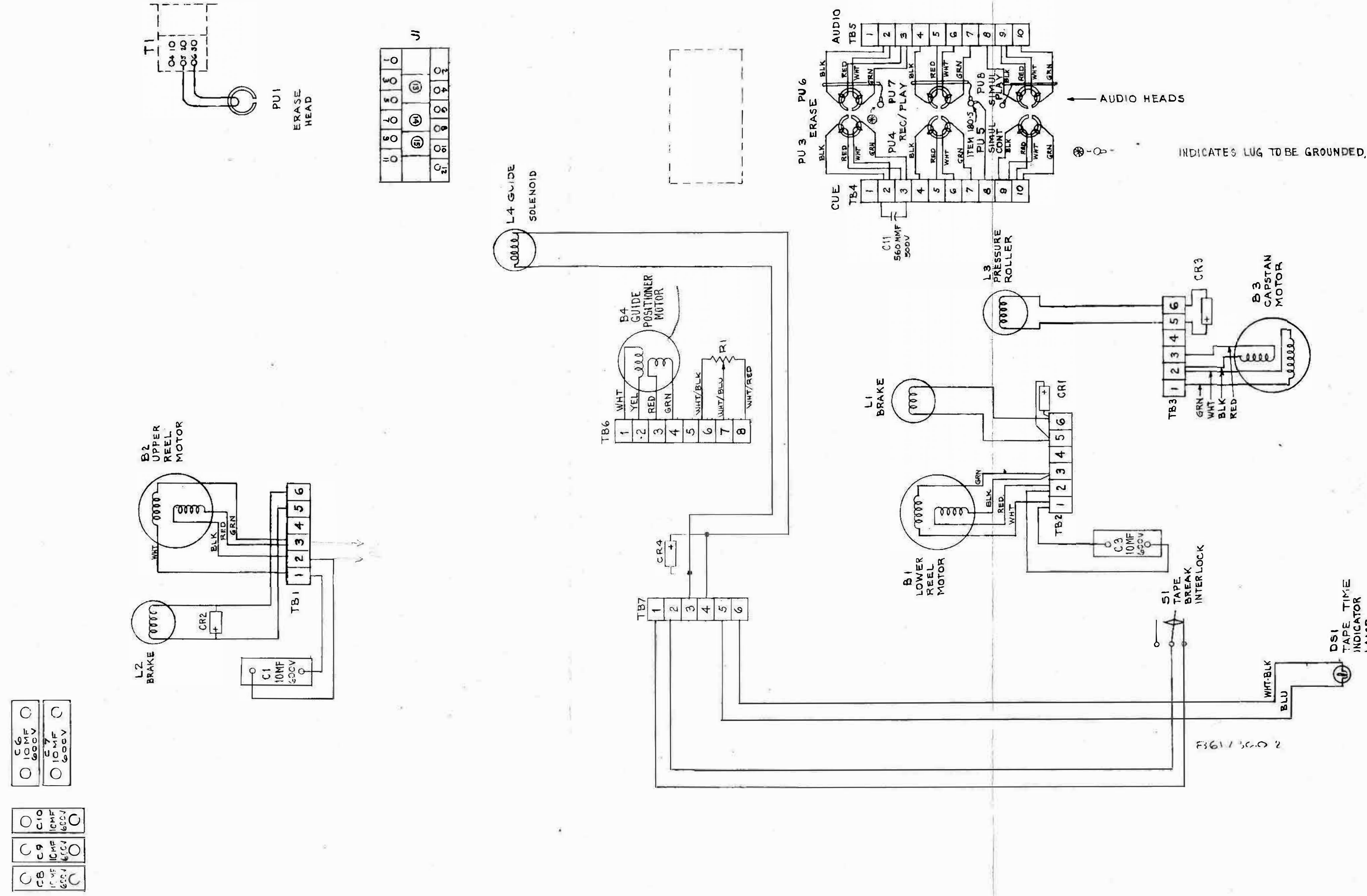

Figure TTP-16. Tape Transport Panel Schematic Diagram

ELECTRONIC RECORDING PRODUCTS

Headwheel Panel

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

Printed in U. S. A.
GO 671

IB-31162

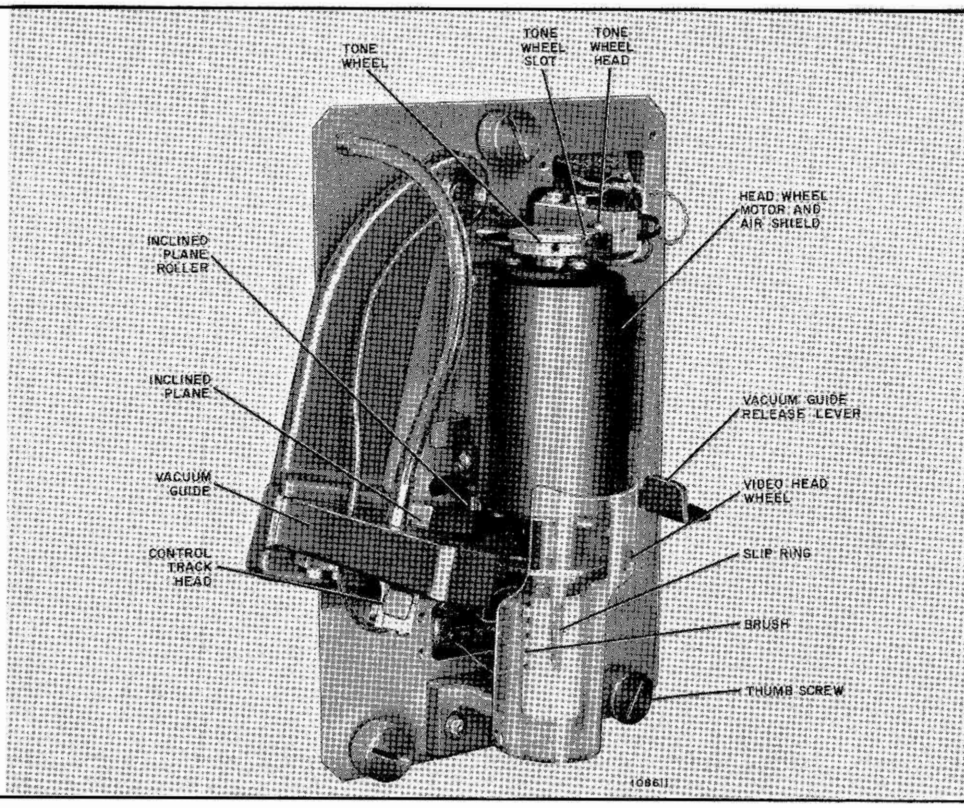

Figure HWP-1A. Headwheel Panel, Vacuum Guide Open

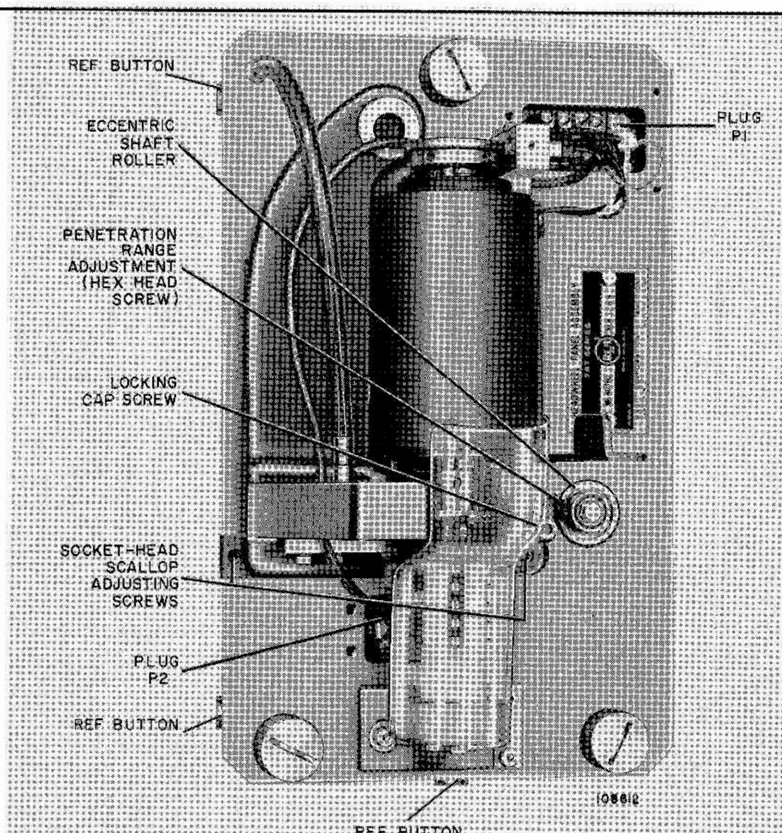

Figure HWP-1B. Headwheel Panel, Vacuum Guide Closed

DESCRIPTION

The Headwheel Panel Assembly (figure HWP-1) is a separate removable panel that is attached to the tape transport panel (unit 200) by three captive thumb screws. The principle parts of this assembly are: headwheel, headwheel motor, brush and slip-ring assembly, control-track head, tonewheel, tone-wheel head, and vacuum guide assembly.

The transverse recording and playing back of video signals is performed by the headwheel panel assembly. The headwheel motor is a 3-phase, hysteresis synchronous type running at a nominal speed of 240 revolutions per-second (14,400 rpm). It is surrounded by a shroud that serves as a magnetic shield, and a duct for cooling the motor and cleaning the air around the headwheel. The cooling air is drawn in at the headwheel, and exhausted through the mounting plate to the headwheel blower.

The headwheel is a non-magnetic wheel with four equally spaced heads mounted in it; it has an approximate diameter of 2.0642 inches. When new, the poles of the heads have a protrusion of approximately 0.003 of an inch. The headwheel and magnetic head assemblies are the most precise parts of the equipment. To facilitate the recording or playing back of interchangable recordings, the quadrature of the heads in the wheel is set to plus or minus 15 seconds of arc; this is equivalent to 0.05 microsecond of time with the headwheel rotating at 240 rps. In addition the tape recorder provides an adjustable electrical delay so that the final headwheel quadrature accuracy can be set to plus or minus 0.01 microsecond.

The tonewheel and pickup head are located at the top of the headwheel motor. The tonewheel is mounted on the motor shaft, and consists of a steel disc with a notch in the periphery; the notch in the tonewheel interrupts the flux path of the pickup head on each revolution. This interruption produces a 240 cycle pulse that is compared with a fixed reference pulse providing an error signal to control the headwheel motor speed.

The vacuum guide is a solid block of non-magnetic material that has an inner radius of approximately 1.0329 inches. It has three slots cut into it, the center slot provides clearance for the pole tip protrusion and the two outside slots have a vacuum applied to them to hold the tape against the vacuum guide and shape it. The vacuum guide is mounted on an arm that is pivoted near the top of the headwheel panel and is supported on the bottom by two adjustable pads that are used to position the guide perpendicular to the panel. The guide arm is held against the panel and the eccentric shaft by the release arm. The motion of the eccentric shaft brings the tape into contact with the headwheel. The eccentric shaft is moved by the vacuum guide solenoid located on the rear of the tape transport panel. The solenoid coupling engages the pin on the eccentric shaft and when energized rotates the eccentric shaft until the arm stops against the drive screw of the vacuum guide servo motor assembly. The position of the drive screw determines the amount of headwheel penetration.

Mounted on the bottom of the vacuum guide is the control track head. In the record mode, this head records a control track on the tape. When in the play mode the control track head picks up this signal, and it is used by the capstan servo system to provide proper tracking between the video heads and the recorded information.

The slip ring and brush assembly at the bottom end of the motor shaft is used to couple the fm signals to and from the video heads.

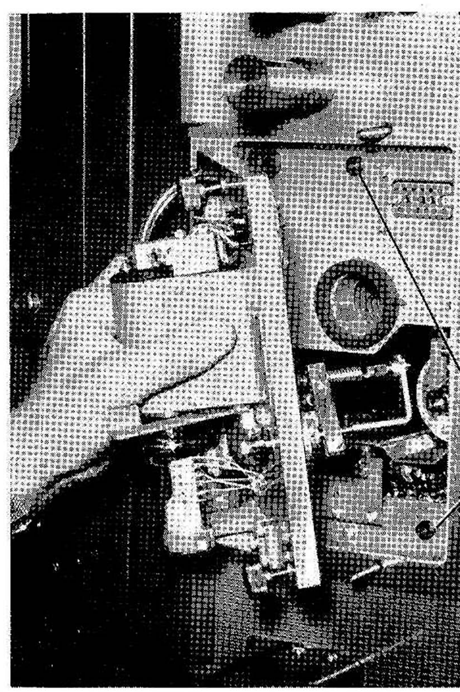

Figure HWP-2. Installation of Headwheel Panel

INSTALLATION

Unpacking

The headwheel panel is shipped in a carrying case equipped with a shock mount support. It should be kept in this carrying case at all times except when in actual use. To remove the headwheel panel from its carrying case proceed as follows:

1. Loosen the three captive knurled screws by turning in a counterclockwise direction.

2. Grasp the headwheel panel by the motor shield with the left hand and lift it out of the carrying case.

Installation in Tape Recorder

To install the headwheel panel in the TRT Television Tape Recorder see figure HWP-2 and proceed as follows:

1. Remove the headwheel panel cover.

2. Grasp the headwheel panel by the motor air shield and insert it into the tape transport panel cutout with the brush and slip-ring assembly at the bottom and the tonewheel at the top. The vacuum guide actuating shaft, and the pins of plugs P1 and P2 should fit into their respective counterpart on the tape transport panel.

3. Tighten the captive knurled thumb screws securely while pushing in on the headwheel panel. The two reference buttons on the left-hand side of the headwheel panel are pressed against the side of the tape transport panel cutout, and the reference button at the bottom of the headwheel panel touches the bottom of the cutout on the tape transport panel.

NOTE: Make sure that the headwheel is held firmly against the locating bushing on the tape transport panel by the three captive thumb screws.

4. Replace the headwheel panel cover.

5. Record the reading on the control panel HEAD HOURS indicator before placing it in operation.

Removing Headwheel Panel

To remove the headwheel panel from the tape transport panel reverse the procedure as given under "Installation in Tape Recorder," and be sure to record the reading on the HEAD HOURS indicator.

Return Authorization Form

Included in the carrying case in a form entitled "RETURN AUTHORIZATION," which should be properly filled out before returning the headwheel panel.

OPERATION

Cleaning

The headwheel panel should be cleaned every day prior to commencing operation or before each recording if conditions warrant. Dirty tape and dust in the room are two causes for the accumulation of dirt on the tape guides, resulting in scratches or incorrect pressure due to the piling up of oxide and dirt in the vacuum guide. This condition can be minimized by keeping the protective covers on both the headwheel panel and the audio heads. Clean the headwheel panel with a lint-free cloth or tissue dampened with a solvent such as Freon TF.*

Other solvents such as chlorothene, inhibisol, or pure grain alcohol may also be used.

WARNING

DO NOT BLOW ON THE HEADWHEEL TO CLEAN IT, FOR THIS MAY DRIVE DIRT INTO THE BALL BEARINGS. ALL SOLVENTS EXCEPT "FREON TF" MUST BE KEPT OFF OF THE TAPE.

To clean the headwheel panel proceed as follows:

1. Remove the tape from the tape transport panel.

2. Remove the headwheel panel protective cover by loosening the captive screws at the bottom and top of the protective cover, and pull the cover away from the tape transport panel.

3. Open the vacuum guide by pressing the vacuum guide release lever to the right and at the same time pushing the vacuum guide to the left until it pivots upward.

4. Clean the headwheel rim and video heads with a lint-free cloth or tissue dampened with solvent.

5. Clean the vacuum guide by wiping the tape supporting surfaces with a lint-free cloth or tissue dampened with solvent. Stubborn accumulations of oxide may be scraped away using a wooden toothpick. Care should be taken to protect the tape supporting surfaces from scratches. Make sure that the vacuum passages in the guide are clear.

6. Clean the control track head by wiping with a lint-free cloth or tissue.

7. Clean the inclined plane on the vacuum guide arm, and the roller on the release lever.

8. Clean the eccentric shaft roller, and the head of the range adjustment hex-head cap screw.

Alignment

The making of interchangeable video tapes using this headwheel panel depends in part on the accurate positioning of the vacuum guide of the headwheel panel. Several adjustments may be necessary before commencing operation. The adjustments to be made

---

* Freon TF is a commercial solvent manufactured by the E. I. DuPont De Nemours & Co. (Inc.), Wilmington, Delaware; it can be purchased from the John B. Moore Corp., Peerles Building, P. O. Box #3, Nutley, N. J. or other authorized re-packers.

are: (1) Scallop Adjustment (placing the vacuum guide in the correct position perpendicular to the panel); (2) Jog Adjustment (penetration or alignment parallel to the panel); (3) Head current optimization; (4) Quadrature Adjustment.

Errors in the vacuum guide position are determined by using an RCA Alignment Tape (MI-40771-B) which is recorded under optimum conditions. Playback of this tape under conditions other than optimum will show up as time displacements in the reproduced picture. These visible deviations can be separated into three basic errors: (1) errors perpendicular to the headwheel panel called "scallops" (refer to figure HWP-3A); (2) errors in pressure called "jogs" (refer to figure HWP-4A); (3) errors in time delay called quadrature errors (refer to figure HWP-5). Combinations of these three errors usually occur.

Equipment Required — Both the vacuum guide penetration and quadrature adjustments require the following wrenches:

1. 1/4-inch open-end wrench (MI-40769, Item 7) for jog adjustment.

2. 1/8-inch socket wrench (MI-40769, Item 8) for jog adjustment.

3. 3/32-inch socket wrench (MI-40769, Item 9) for scallop adjustment.

Concentricity Adjustment—The first adjustment to be made, when installing a headwheel panel, is the removable of scallops or bows in the picture (as viewed on the picture monitor). The procedure to be used is as follows:

1. Install the standard alignment tape (MI-40771B), on the recorder.

CAUTION: Do not put the tape recorder in the SETUP or RECORD mode of operation while the alignment tape is threaded since portions of the test tape may be erased.

2. Put the GUIDE POSITION switch in AUTOMATIC and place the tape recorder in the PLAY mode by pushing the PLAY button. Press the 2 X 1 OUT button on the OSCILLOSCOPE switch and adjust the CONTROL TRACK PHASE knob for maximum output. Then press the LINE OUT button on the MONITOR switch and observe the picture monitor.

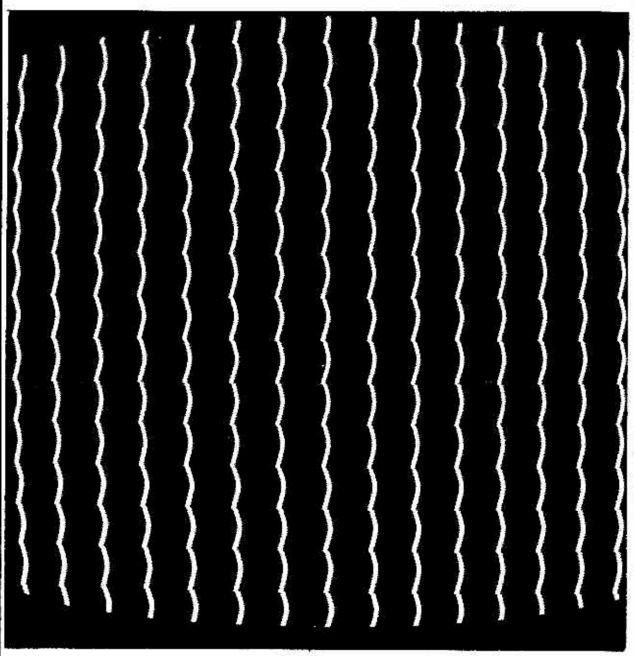

Figure HWP-3A. Scallops in Bar Pattern; Vacuum Guide Too Far in (Turn Screw Clockwise to Correct)

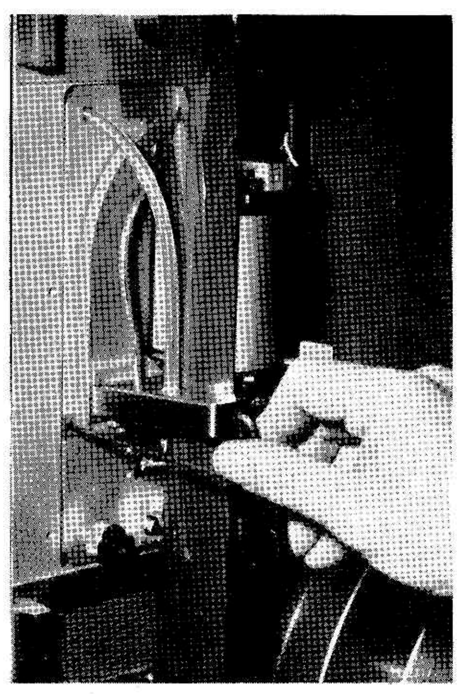

Figure HWP-3B. Socket Head Adjusting Screw Adjustment

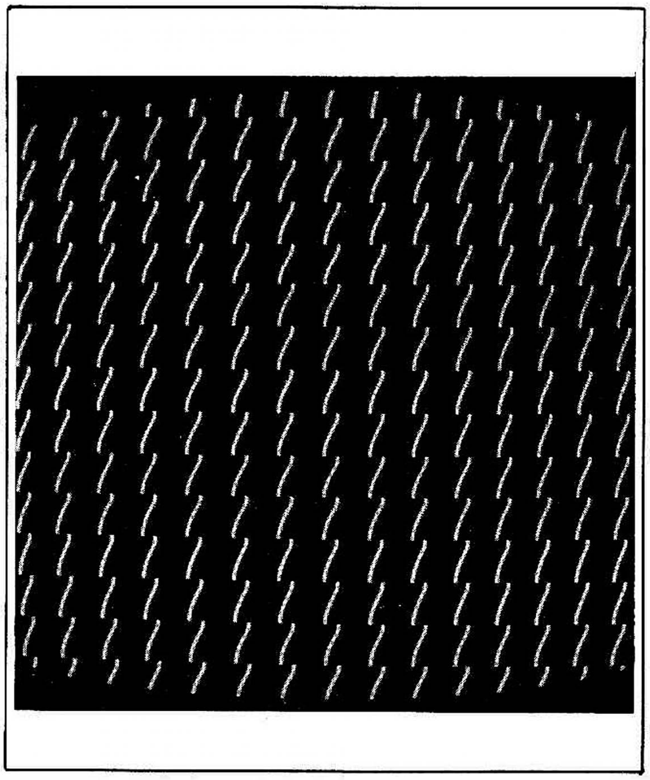

Figure HWP-4A. Jogs in Bar Pattern Caused by Insufficient Head Penetration (Move Wrench UP to Correct)

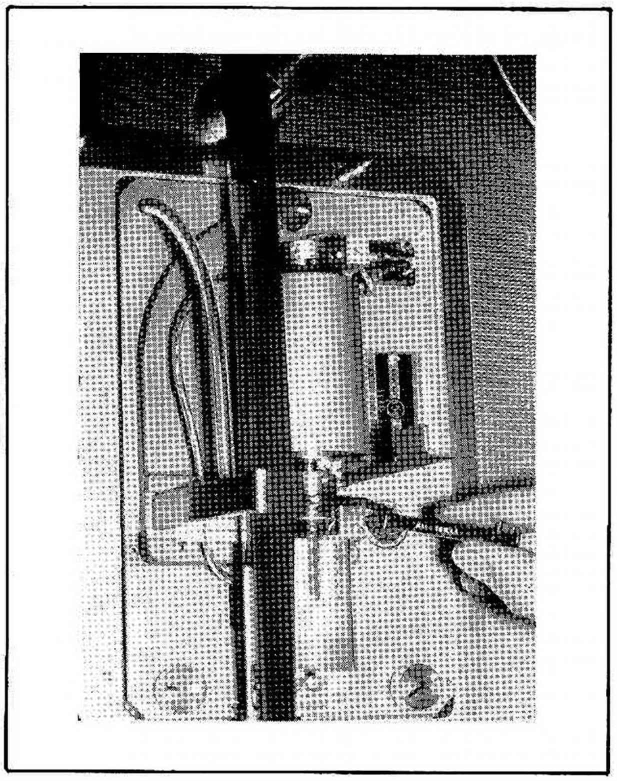

Figure HWP-4B. Locking Cap Screw for Head Penetration Adjustment

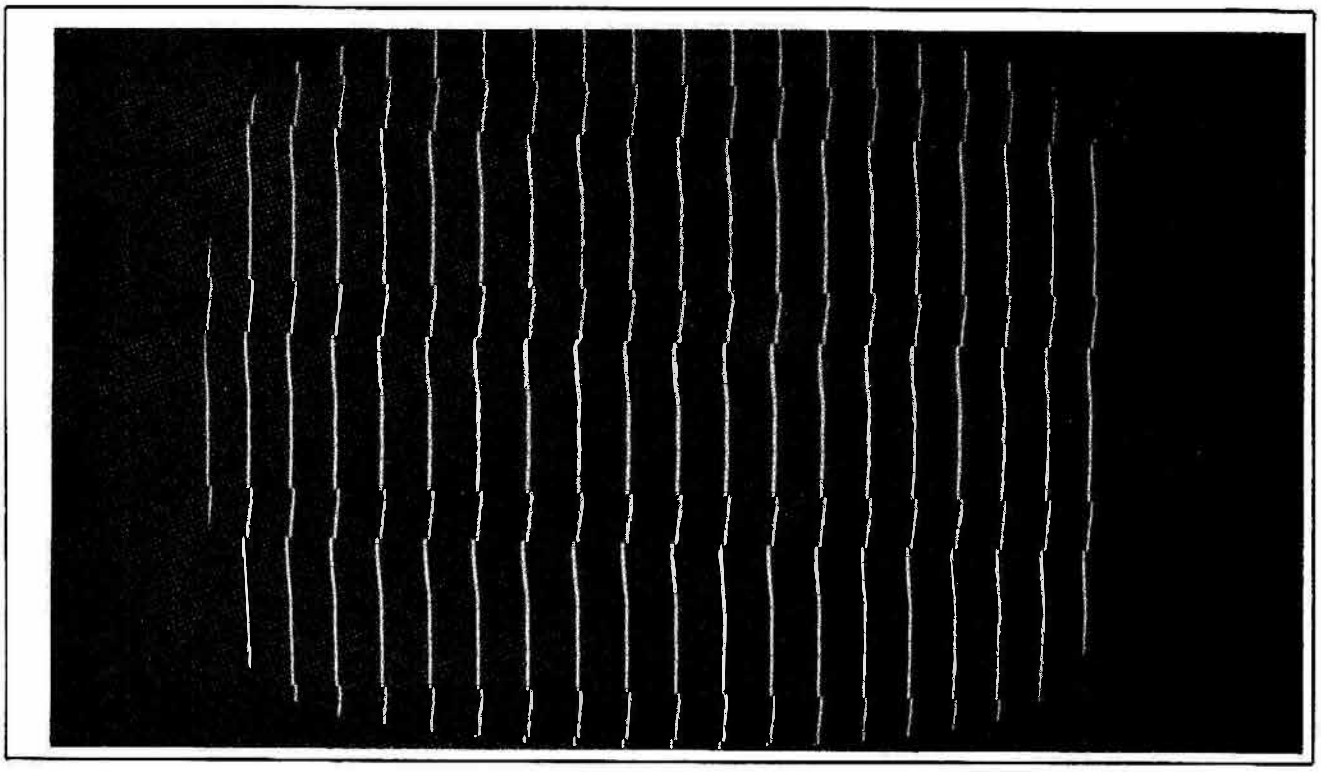

Figure HWP-5. Quadrature Errors in Bar Pattern

NOTE: If the vacuum guide is out of its penetration range (jogs in the picture) a rough adjustment of the hex-head range screw should be made by following the procedure as outlined in steps 3 and 4 of "Penetration Adjustment."

3. Insert a 3/32-inch socket wrench (MI-40769, Item 9) into the socket-head adjusting screw (figure HWP-3B). The adjusting screw is located on the front of the headwheel panel to the left of the vacuum guide and arm. If the scallops are concave to the right, turn the socket-head adjusting screw in a counterclockwise direction until the scallops disappear. If the scallops are concave to the left, turn the adjusting screw in a clockwise direction until they disappear.

Penetration Adjustment—After the vacuum guide is adjusted to remove scallops the penetration is to be set as follows:

1. Place the control panel GUIDE POSITION switch (AUTOMATIC—MANUAL) in the MANUAL position.

CAUTION: Do not put the tape recorder in the SETUP or RECORD mode of operation while the alignment tape is threaded since portions may be erased.

2. Set the GUIDE POSITION control to "0" on the scale.

3. Install the standard alignment tape (MI-40771B).

WARNING

THE FOLLOWING ADJUSTMENTS REQUIRE TOOLS TO BE PLACED NEAR THE ROTATING HEADWHEEL. CARE SHOULD BE TAKEN TO PREVENT DAMAGE TO THE WHEEL, BY HAVING THE PLASTIC SHIELD IN PLACE.

4. Loosen the locking cap screw, located in the right-hand corner of the vacuum guide, with the 1/8-inch socket wrench (MI-40769, Item 8).

(A 9/64-inch socket wrench is required on some headwheel panels.)

5. Adjust the vacuum guide for satisfactory playback (no jogs) by rotating the hex-head screw, located above socket-head cap screw loosened in step 4 above, using a 1/4-inch open-end wrench (MI-40769, Item 7).

NOTE: To facilitate this adjustment make sure that the playback delay lines are adjusted to give approximately correct quadrature as outlined under "Quadrature Adjustment."

6. Check the operation of the vacuum guide. This is accomplished by opening and closing the vacuum guide several times by pressing the control panel PLAY button, and after the vacuum guide closes press the control panel STOP button to insure an accurate setting.

7. Tighten the socket-head cap screw loosened in step 4.

Quadrature Adjustments—Errors in quadrature adjustment are compensated for by electronic delay lines in the record delay amplifier and the playback delay amplifier. To adjust these delay lines refer to the section of the Operation Manual entitled, "Head Quadrature Adjustment" or to the instruction book on the particular unit.

Head Current Optimization

To obtain optimum results during recording, the record currents must be adjusted by turning the four GAIN controls on the record amplifier until each of the four heads in the headwheel just saturates the tape when a normal input signal is applied. The following two procedures, one for monochrome and the other for color, permit the determination of these optimum record currents for a particular headwheel panel. Since the optimum currents change with wear, and the heads wear unequally, the procedure will have to be repeated whenever the following indications are obtained:

1. Poor signal-to-noise ratio.
2. Bands of unequal contrast.
3. Bands of varying hue on color recordings (particularly red and green in yellow areas).

Monochrome

1. Apply a video signal containing a large area of peak white to the input of the tape recorder (e.g., monoscope, slide test pattern, color bars with a split field 100% white bar, etc.).

2. Thread a tape on the tape transport panel and set the tape time indicator to zero.

3. Connect the microphone to the MIC IN jack on the audio panel (unit 204), and set the MIC INPUT SEL switch in the AUDIO position.

4. Press the control panel SETUP button and check the recorder for proper adjustment before recording. (e.g., input level, modulation deviation, headwheel servo lock, etc. A complete procedure is given in the Operations Manual.)

5. Press the control panel RECORD button.

6. Set the record amplifier GAIN-1 control to zero, speak into the microphone and announce the

channel number and control position. ("This is channel No. 1 at zero.")

7. Successively advance the control from one number to the next. Stop at each position momentarily and announce the control position into the microphone. Continue this procedure until position 10 is reached and then repeat the procedure in the reverse direction until the control is back at zero. (e.g., 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, 0.)

8. Return the GAIN-1 control to its mid range position.

9. Repeat the procedure given in steps 13, 14, and 15 for channels 2, 3, and 4; then rewind the tape to beginning of test recording.

10. Press the control panel PLAY button.

11. Adjust the control panel CONTROL TRACK PHASE control until the information that was recorded by head number 1 is played back by head number 1. This can be checked by observing the 2 X 1 OUT on the C.R.O. monitor. When playing back the segment of tape where channel #1 current is varied, observe that this corresponds to the channel that loses gain when the channel 1 shorting button is pushed on the equalizer.

12. Set the equalizer H.F. COMP. controls to a position between 2 and 3 on the scale, and the 2 x 1 switcher H. FREQ. COMP. control to position 5.

13. Observe the output of the 2 X 1 switcher on the oscilloscope. While watching the changing pattern listen to the audio playback to identify, in turn, the setting of each of the four gain controls that produces maximum r-f output. The maximum r-f level remains stationary over a narrow range of record currents. The correct current setting is the one that just produces the maximum level. In other words, when the current is slightly above the knee of the curve.

14. Set the record amplifier controls labeled GAIN-1, -2, -3, -4, to the optimum positions determined in step 13.

15. After setting the record amplifier gain controls, record several minutes of the test signal. Observe the control panel RECORD CURRENT meter and, for future reference, write down the four current readings corresponding to the optimum gain settings.

16. Rewind the tape to the start of the last recording and play back the material recorded in step 15.

17. On the cro/monitor switch press the OSCILLOSCOPE button 2 X 1 OUT, and adjust the playback delay amplifier GAIN CHAN-1, CHAN-2, CHAN-3, and CHAN-4 controls for equal signal amplitude.

18. While observing the output of the 2 X 1 switcher on the cro waveform monitor adjust the tonewheel amplifier DELAY 960 control to eliminate any gaps in the head switching. (This may also be done while watching LINE OUT on the picture monitor. The switching gaps appear as white lines in the picture.)

Color

1. Repeat steps 1 through 18 of the monochrome optimization procedure.

2. Apply a color bar test signal, having a split field with a 100% white bar, to the video input of the tape recorder, and record 3 minutes of tape.

3. Rewind the tape and play back this recorded segment of tape.

4. Press the LINE OUT button on the color monitor switcher.

5. Observe the presentation on the color monitor, and adjust the four-channel equalizer H.F. COMP. CH-1, CH-2, CH-3, and CH-4 controls to eliminate bands in the red bar. (The hue of the bar between channels should be identical.)

6. During the test playback, if a particular band in the yellow bar appears greenish, increase the record current for that particular head by turning the corresponding channel GAIN control on the record amplifier in a clockwise direction by about one-half of a division. If a band in the yellow bar appears to be orange, decrease the record current for that particular head by turning the control counterclockwise for about one-half of a division. Then make another test recording, play it back, equalize each channel as in step 5, and, if required again adjust the record currents to correct orange and green banding in the yellow bar. Repeat this procedure until all bands in the yellow bar match.

7. Write down the final record currents for future reference.

8. Observe the demodulator output on the cro monitor and adjust the 2 x 1 equalizer H.F. COMP. control for normal chroma amplitude.

MAINTENANCE

Degaussing

The four video heads of the headwheel should be degaussed (demagnetized) if necessary. To degauss the heads, energize the head demagnetizer coil (MI-40769, Item 1) and bring the coil near the headwheel and slowly remove it, while the tonewheel disc by hand.

Pole Tip Protrusion Measurement

To measure the pole tip protrusion, the dial indicator and mount is used (MI-40769, Item 2). It is advisable to make this measurement with the headwheel panel in its carrying case. If it is made with the headwheel panel installed in the tape transport, the 24 volt power supply switch should be placed in the off position to prevent operation of the headwheel motor while the dial indicator is mounted on the panel as it will damage the video heads. The procedure is as follows:

1. Clean the four heads and headwheel rim.

2. Mount the dial indicator as shown in figure HWP-6; by removing the lower right hand knurled mounting screw and inserting the dial indicator mounting screw. Make sure that the headwheel is turned so that the indicator contact point touches the headwheel rim and not the heads. The dial indicator range is 0.025 of an inch, and the indicator should be positioned touching the headwheel rim so that the contact point can be raised approximately .020 of an inch to clear the video heads. Tighten the dial indicator mounting screw.

3. Push the dial indicator lifter arm, thereby lifting the contact point away from the headwheel and holding it in this position, and rotate the headwheel until a point midway between heads number 1 and 2 is under contact point. This point is called the tip protrusion reference point. Lower the contact point carefully by releasing the lifter arm until the contact point touches the headwheel rim.

4. Tap the headwheel panel lightly until the dial indicator establishes a firm contact.

5. Loosen the dial locking knob on the dial indicator, and rotate the dial until the pointer reading is zero (0). Tighten the locking knob.

6. Push the dial indicator lifter arm until the contact point is lifted away from the headwheel, and rotate the headwheel until the required video head is under the contact point.

7. Gently move the lifter arm until the contact point rests on the pole tip; tap the headwheel panel lightly until a firm setting is obtained.

8. Gently rotate the headwheel back and forth through a small arc until a maximum reading is obtained. Record this reading.

9. Repeat the procedure for the other three video heads.

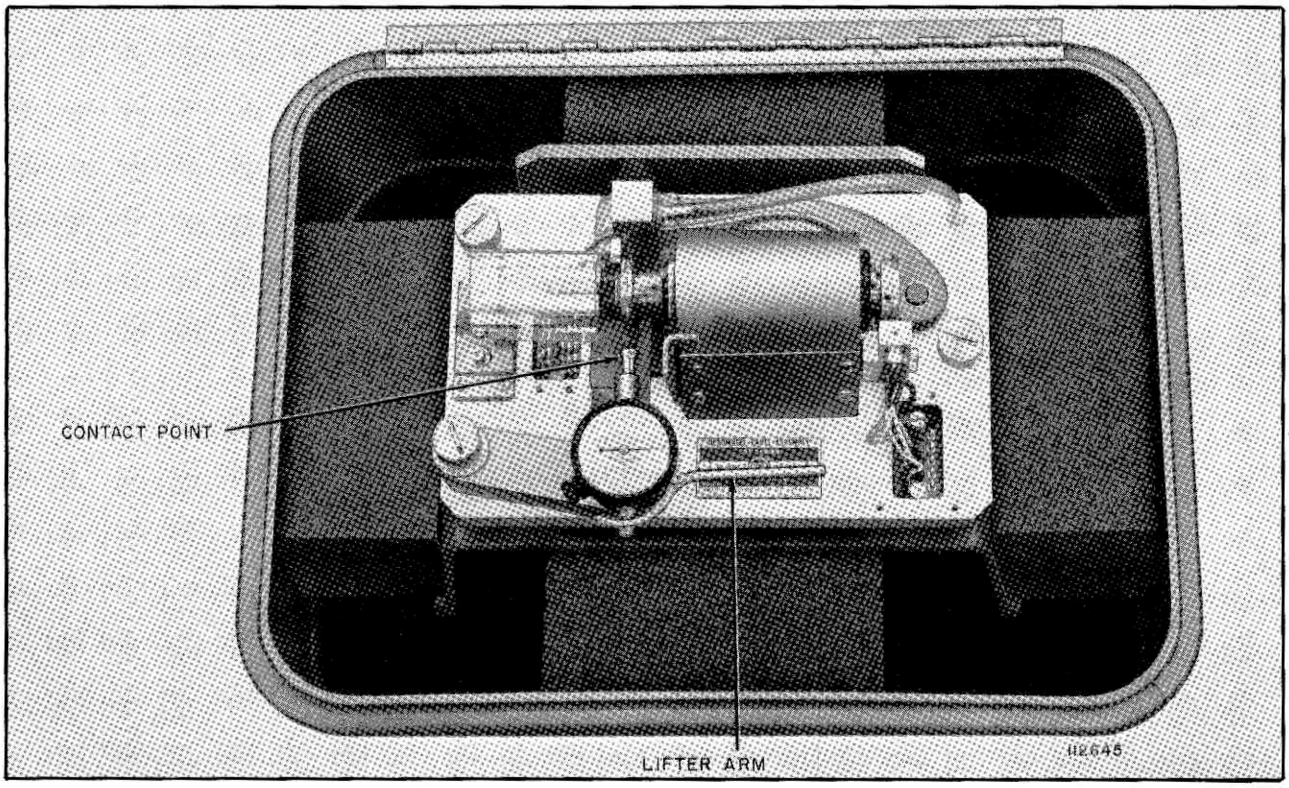

Figure HWP-6. Dial Indicator Mounted on Headwheel Panel (Headwheel Panel Should be in its Carrying Case for this Measurement)

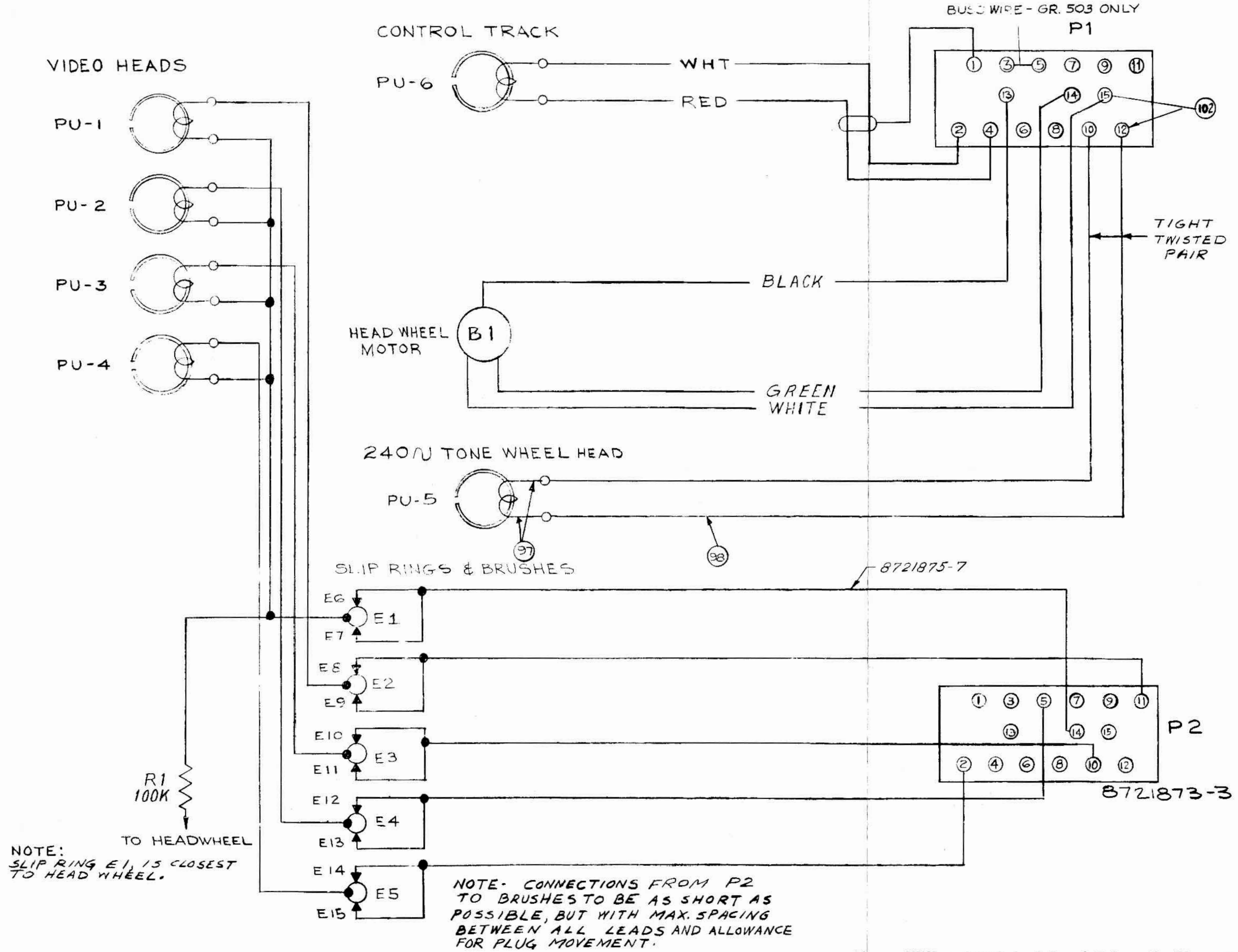

Figure HWP-7. Headwheel Panel Schematic Diagram

Video Preamplifier

UNIT 203

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

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WA 631

IB-31141

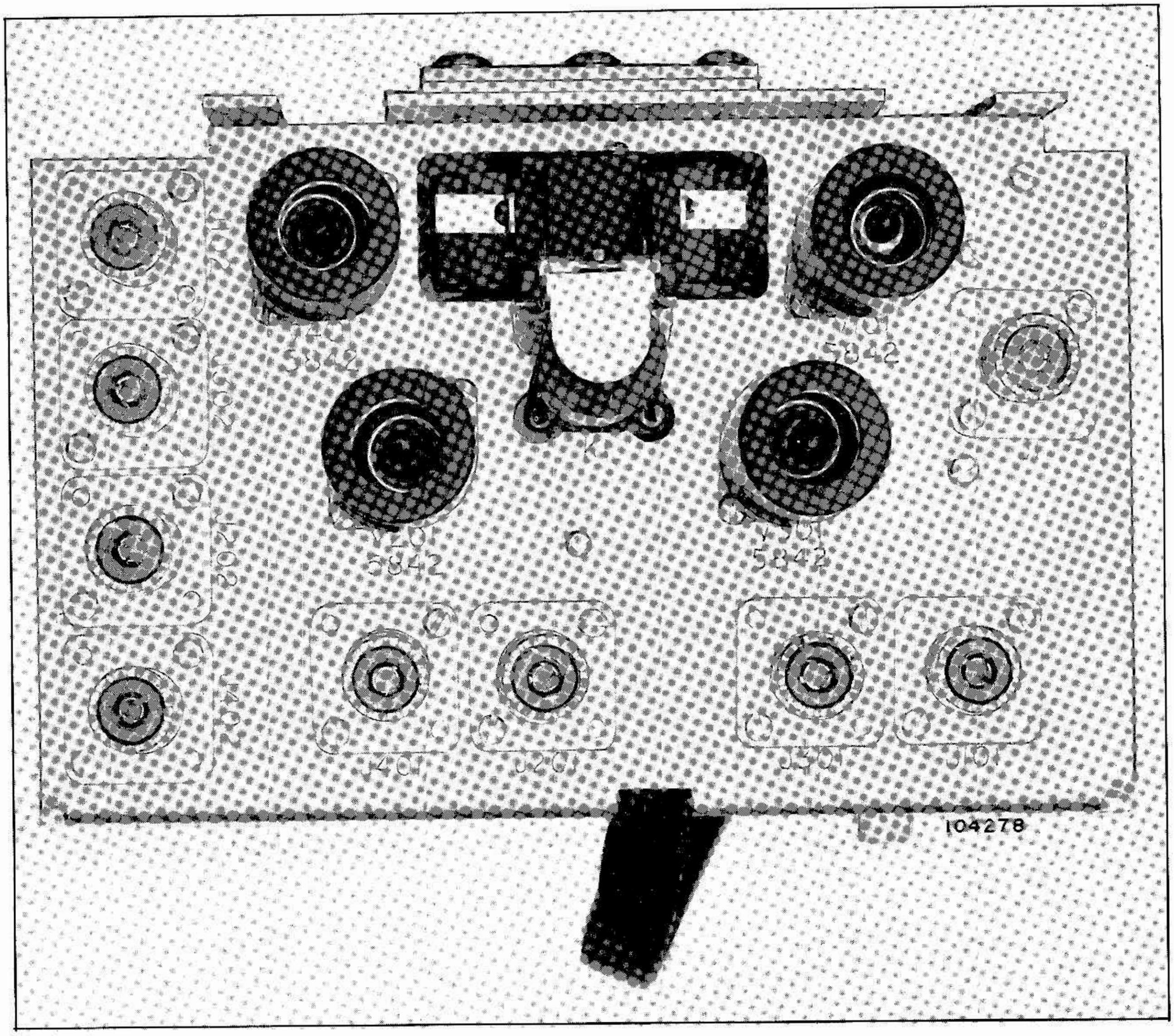


Figure VP-1. Video Preamplifier, Tube Side

TECHNICAL DATA

Power Required

6.3-volts ac filament voltage from playback amplifier (unit 109)

24 volts dc from 24 volt power supply (unit 507)

Tube and Diode Complement

Tubes: 4 — 5842

Diodes: 2 — 1N34A

DESCRIPTION

The video preamplifier (unit 203) is mounted on the tape transport panel (unit 200), directly behind the headwheel panel, and is enclosed in a removable metallic shield. Figures VP-1 and VP-3 show tube and wiring sides of the preamplifier with the shield removed.

The primary purpose of the preamplifier is to provide initial amplification of signal currents derived from the four video heads during the PLAY mode of operation before they are fed to the playback amplifier (unit 109). In the RECORD mode, a relay mounted on the chassis is energized allowing the four inputs from the record amplifier (unit 104) to be applied directly to the individual video heads. Additional circuitry is provided on the preamplifier chassis to rectify the total head current before it is fed to the VIDEO METER SEL switch on the control panel (unit 305).

Circuit

In the PLAY mode of operation the four individual head currents are fed to the preamplifier at input jack J3. (Refer to schematic diagram, figure VP-4.) Each signal is applied to an independent half-stage of cascode amplification. The output of each amplifier is fed to the second half-stage of amplification on the playback amplifier. Cascode amplifiers are used in this application to insure high gain with a minimum noise level and to provide a low impedance input to the playback amplifier, where it is more convenient to amplify the signal. Extensive use of shielding and special circuit design are utilized to provide a high signal-to-noise ratio.

In the RECORD mode of operation, 24 volts dc is applied to relay K1 through plug P2. Energizing K1 removes the preamplifier from the circuit and allows the four input signals from the record amplifier (unit 104) to be fed to the individual video heads.

Test point TP1 is provided for convenience in monitoring the total head current (figure VP-2). A rectifier circuit, including diodes CR1 and CR2, rectifies the total head current before it is fed to the VIDEO METER SEL switch on the control panel.

To gain access to relay K1 or circuit components for circuit checking purposes, remove the metallic cover which is held in place by four thumb screws. (The cover must always be in place while operating the tape recorder so that the required shielding is provided.)

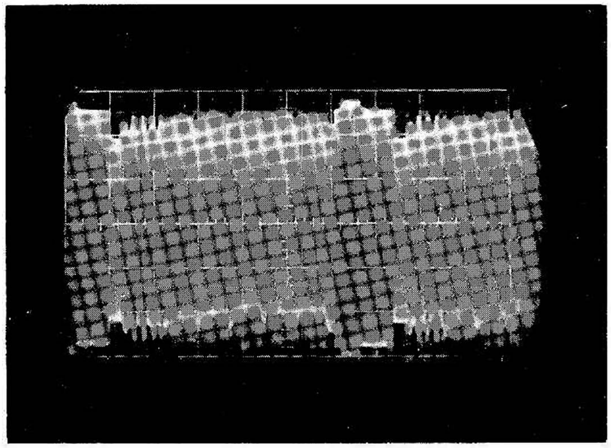


Figure VP-2. Total Head Current at TP1

The preamplifier may be detached from the tape transport panel for ease in replacing the relay or circuit components. To detach the unit, remove the headwheel panel and loosen the three small allen-head capscrews which fasten the unit to the tape transport panel. *It is necessary to hold the unit from the rear of the rack when the capscrews are removed.*

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
PREAMPLIFIER ASSEMBLY (8974418-502) 4			
			CAPACITORS:
C1 to C4		8811182-5	Ceramic, 10,000 $\mu\mu$f +100 -20%, 450 v
C5 to C100			Not Used
C101A/B	218128	8971848-10	Ceramic, 0.005/0.005 μf +80 -20%, 150 v
C102	205117	737818-335	Paper, 0.22 μf ±10%, 100 v
C103 to C200			Not Used
C201A/B	218128	8971848-10	Ceramic, 0.005/0.005 μf +80 -20%, 150 v
C202	205117	737818-335	Paper, 0.22 μf ±10%, 100 v
C203 to C300			Not Used
C301A/B	218128	8971848-10	Ceramic, 0.005/0.005 μf +80 -20%, 150 v
C302	205117	737818-335	Paper, 0.22 μf ±10%, 100 v
C303 to C400			Not Used
C401A/B	218128	8971848-10	Ceramic, 0.005/0.005 μf +80 -20%, 150 v
C402	205117	737818-335	Paper, 0.22 μf ±10%, 100 v
CR1, CR2	59395		Diode: type 1N34A
J1	51800	255223-2	Connector: coax, chassis mtg.
J2			Not Used
J3	205331	8980016-1	Connector: female, 5 contact
J4 to J100			Not Used
J101, J102	51800	255223-2	Connector: coax, chassis mtg.
J103 to J200			Not Used
J201, J202	51800	255223-2	Connector: coax, chassis mtg.
J202 to J300			Not Used
J301, J302	51800	255223-2	Connector: coax, chassis mtg.
J303 to J400			Not Used
J401, J402	51800	255223-2	Connector: coax, chassis mtg.
K1	218949	470678-10	Relay: 24 v, D.C., SPDT, complete with 4 micro-switches
	212301		Microswitch only for Relay K1

Symbol No.	Stock No.	Drawing No.	Description
P1	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P2	58978	727969-6	Connector: male, 8 contact
P3 to P100			Not Used
P101	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P102			See miscellaneous
P103 to P200			Not Used
P201	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P202			See miscellaneous
P203 to P300			Not Used
P301	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P302			See miscellaneous
P303 to P400			Not Used
P401	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P402			See miscellaneous
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		82283-159	1000 ohm ±5%, ½ w
R2	215410	990733-101	Film, 10 ohm ±1%, 1 w
R3 to R100			Not Used
R101		82283-86	100,000 ohm ±10%, ½ w
R102	209626	990730-130	Film, 20 ohm ±1%, ½ w
R103 to R200			Not Used
R201		82283-86	100,000 ohm ±10%, ½ w
R202	209626	990730-130	Film, 20 ohm ±1%, ½ w
R203 to R300			Not Used
R301		82283-86	100,000 ohm ±10%, ½ w
R302	209626	990730-130	Film, 20 ohm ±1%, ½ w
R303 to R400			Not Used
R401		82283-86	100,000 ohm ±10%, ½ w
R402	209626	990730-130	Film, 20 ohm ±1%, ½ w
TP1	208983	8825493-7	Jack: tip, yellow
XV101	94926	737870-14	Socket: tube, 9 pin
XV102 to XV200			Not Used
XV201	94926	737870-14	Socket: tube, 9 pin
XV202 to XV300			Not Used
XV301	94926	737870-14	Socket: tube, 9 pin
XV302 to XV400			Not Used
XV401	94926	737870-14	Socket: tube, 9 pin
V101, V201, V301, V401	219435		Tube: ericsson type 5842
			Miscellaneous:
	223112	8980161-501	Cable Assembly complete, unstenciled, (Low capacity) Includes coax connectors for the following attachments: 203J102 - 104J102; 203J202 - 104J202; 203J302 - 104J302; 203J402 - 104J402

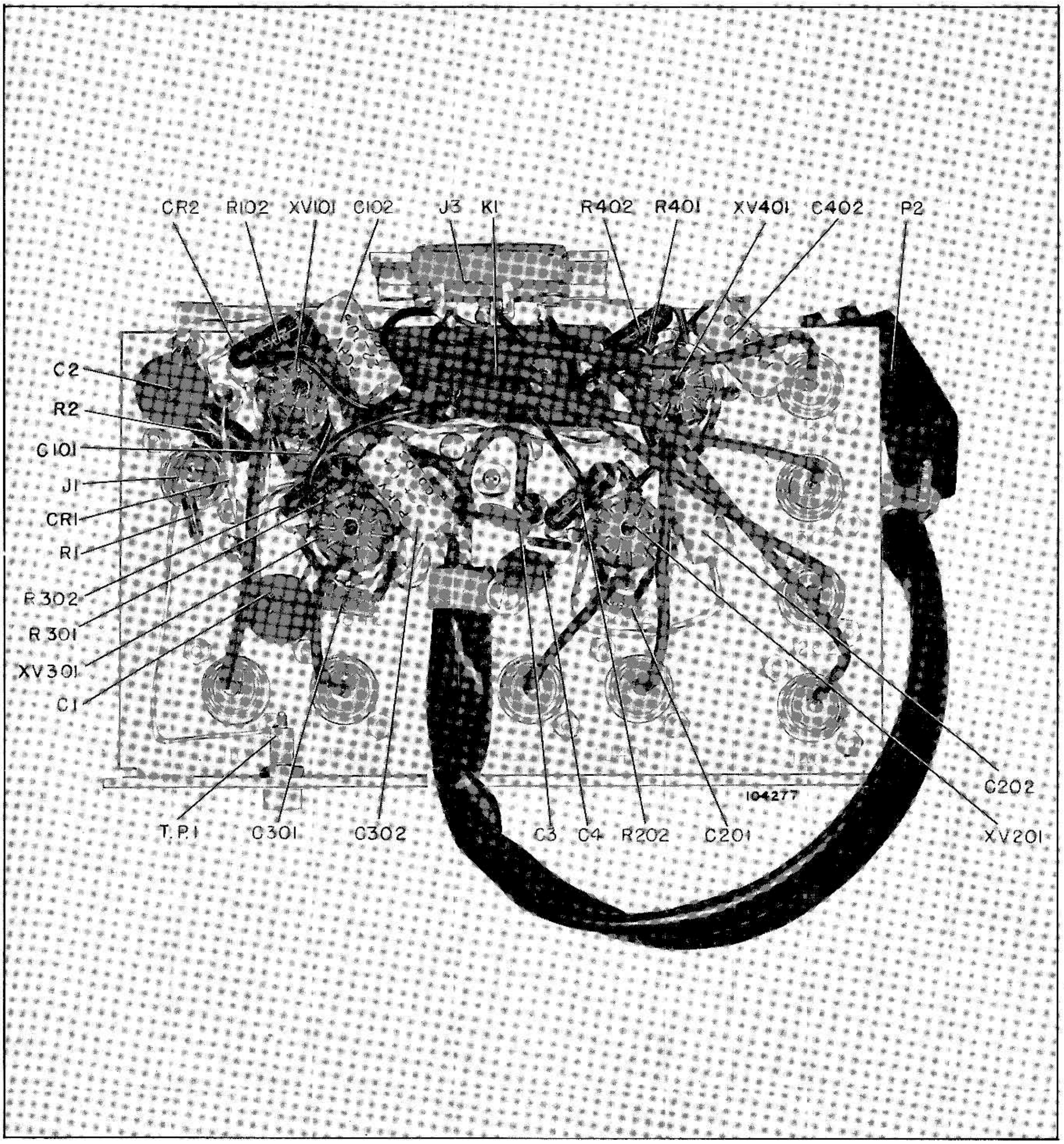


Figure VP-3. Video Preamplifier, Wiring Side

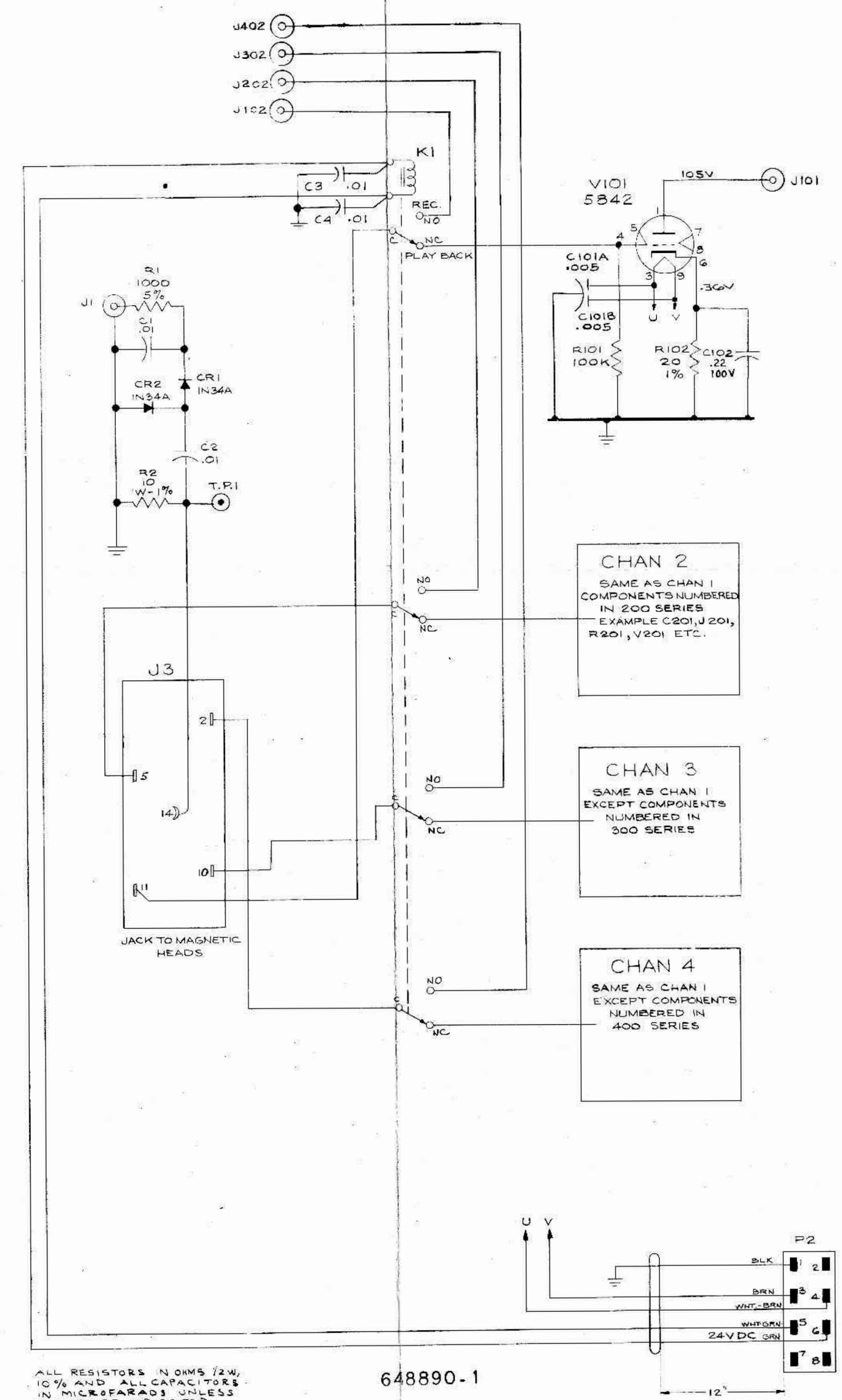


Figure VP-4. Video Preamplifier, Schematic Diagram

Audio Panel

UNIT 204

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31118

PRINTED IN U.S.A.
GO 651

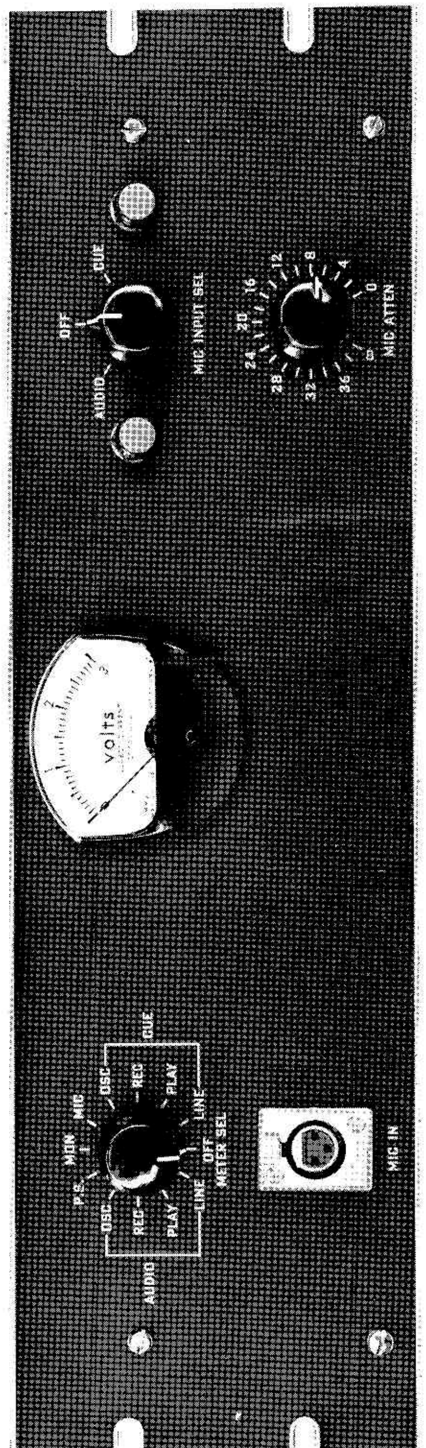


Figure APL-1. Audio Panel

TECHNICAL DATA

Voltage Required

Relays: 24 volts dc, from 24 volt supply (unit 507) controlled by control panel (unit 305)

Flasher: 24 volts dc, from 24 volt supply (unit 507)

Selector Switches

Meter Switch: S1 selects voltages of audio and cue channels (see Schematic Diagram, figure APL-4)

MIC Input Switch: S2 selects audio or cue (local use)

Microphone Attenuator

Variable balanced ladder, 0 to 40 db

Microphone Input

Receptacle provided for local microphone

Relay Complement

2 Telephone Type; 8 pole-double throw, 250 ohm coil
4 Telephone Type; 4 pole-double throw, 600 ohm coil

Indicating Lamps
(used in conjunction with S2 above)

2 GE #327

High-Pass Filter

300 cycles to 10 KC (cue channel) limits crosstalk from adjacent control track channel

DESCRIPTION

The Audio Panel (see figure APL-1) which is located in rack 2, is a junction panel which consists primarily of a metering circuit and relays used in conjunction with audio and cue channel operations. The panel has a voltmeter for monitoring tube voltages of the audio and cue units; also a MIC IN receptacle, MIC attenuator, and a MIC INPUT SEL switch for local microphone use.

The audio panel has three functions in the tape recorder system. It houses the relays (see figure APL-3) which transfer the audio and cue channel signals when operating back and forth between playback and record (see *Audio system schematic* figure APL-5. The audio panel also permits the local use of a microphone for recording either audio or cue information on the tape. Finally it facilitates checking the voltages of the tubes in the audio and cue channels.

Filter for Cue Channel

A high-pass filter, T-1, is mounted behind the audio panel (see figure APL-2). The filter is connected between the cue playback preamplifier (unit 205G) and the cue line amplifier (unit 206A) to rapidly attenuate the cue channel response below 300 cycles. This limits the crosstalk from the adjacent control track which otherwise would produce a 240-cycle signal in the cue channel output.

Relay Sequence Operation

Relays K1, K2, and K3 are in the audio channel; and relays K4, K5 and K6 are used in the cue channel. These relays determine the signal paths of the audio and cue signals when switching between the various Record modes (master, audio or cue record) and the Play mode.

The following explanation will refer mostly to the audio channel since the operational sequence of K4, K5, and K6 in the cue channel, is the same as K1, K2, and K3 respectively in the audio channel. Whenever a difference occurs in the audio and cue relay operation, it shall be noted. Moreover, the references to the audio channel units apply also to the similar units in the cue channel for cue operation.

Reference should be made to the schematic diagram, figure APL-4, during the following explanation.

Relay K1 is a muting relay. When switching back and forth between RECORD and PLAY, K1 operates first in a sequence involving relays K2 and K3, to mute the input to the playback line amplifier. While relay K1 is energized thus muting the signal, K2 operates a fraction of a second later to transfer the head in the record and playback circuits. Thus, the "pop" from the relay transferring the signal is not transmitted to the outgoing audio line. As soon as the head transfer has been completed, the muting relay is released.

When changing from PLAY to RECORD, relay K3 is simultaneously actuated with K2. This enables K3 to supply B+ voltage to the audio record amplifier unit 205B, and the oscillator chassis unit 205C; also, this operation switches the VU meter from the playback circuit to the record circuit.

When going back to STOP or PLAY from record, the above action is reversed. Muting by K1 is always the first operation of the sequence in either direction. However, when going from Play to Stop, there is no operation of the relays because the relays (K1 through K3) are always in the condition for Play and only operate during transition to or from any record mode.

In the Play mode, the two windings in the Audio Rec/Play head are connected in series, and the signal is fed directly to the input of the playback preamplifier unit 205-A (function of K2). The audio simultaneous play head is disconnected from all circuits

when the machine is in this mode; and because there is no B+ voltage on the oscillator, the erase head is inoperative so as not to erase any previously recorded information.

In the RECORD mode, the two windings of the record head are switched by relay K2 in such a manner as to place one winding across the output of the record amplifier and the other winding across C2. This capacitor, C2, located on the audio panel, is used to adjust the bias voltage of the heads. Refer to the Maintenance section of the *Audio Systems* section for adjustment. Simultaneously with the switching of the record heads (in RECORD) the simultaneous play head is connected to the input of the audio playback amplifier (unit 205A).

NOTE: There is no simultaneous play head in the cue channel; however, all other operations for the cue channel, are exactly the same as for the audio channel.

Microphone Input

For local use, a microphone is connected to the MIC IN receptacle, J7, on the front panel. The signal is fed out of the audio panel through J8, to the microphone preamplifier (unit 205H) returning to the audio panel through jack J9 pins y and c. Upon entering through J9, the signal is fed to a MIC attenuator which is a 40 db variable balanced ladder attenuator for controlling the level of the incoming audio/cue information which is to be recorded.

The MIC INPUT SEL switch (normally off) connects the microphone to either the audio or cue recording channel while disconnecting the appropriate program line. One of the two red lights will flash indicating to which channel the microphone is connected. Note however, the incoming program line (audio or cue) is cut off when the MIC INPUT SEL switch is set to the AUDIO or CUE position.

CAUTION: Make certain to return the MIC INPUT SEL switch to the OFF position when local recording is completed, so that the incoming program line will be reconnected to the record amplifier.

Metering

The dc voltmeter (M1) and the METER SEL switch are used for monitoring tube voltages in the audio and cue channels. The METER SEL switch is rotated to indicate the unit within the channel to be checked. A standard reading of 1.0 volt should be read for each position. When no voltage readings are desired, the switch can be set to the OFF position.

MAINTENANCE

The only routine maintenance to be performed on the audio panel is periodic cleaning of relay contacts with a burnishing tool. If any relay becomes inoperative, check for 24 volts coming to the relay in the RECORD mode. If the proper voltage is present and the relay does not operate, inspect it for physical damage; also check the coil for continuity. If a relay needs to be replaced, refer to the *List of Parts* for the necessary data.

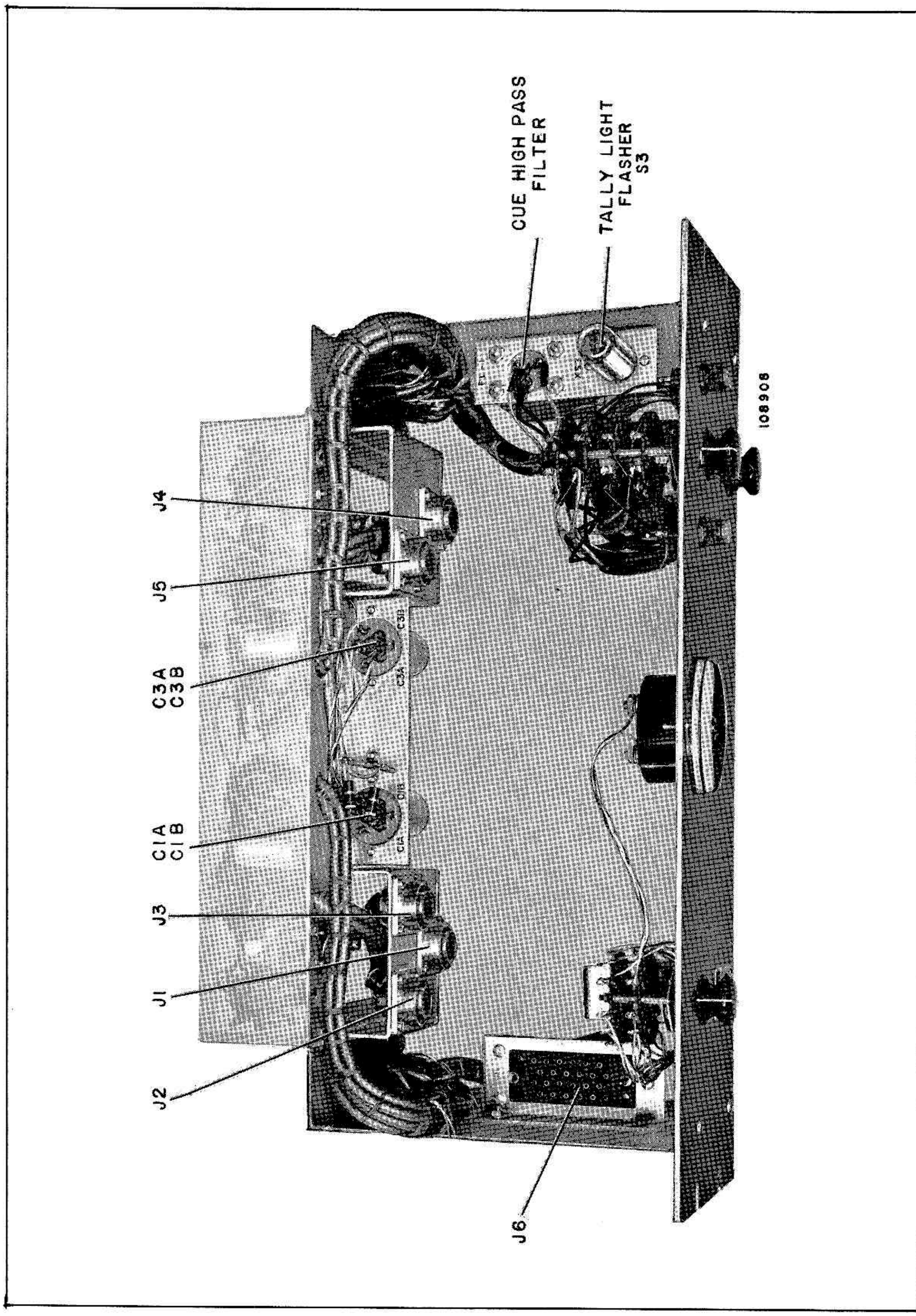


Figure APL-2. Audio Panel, Top View

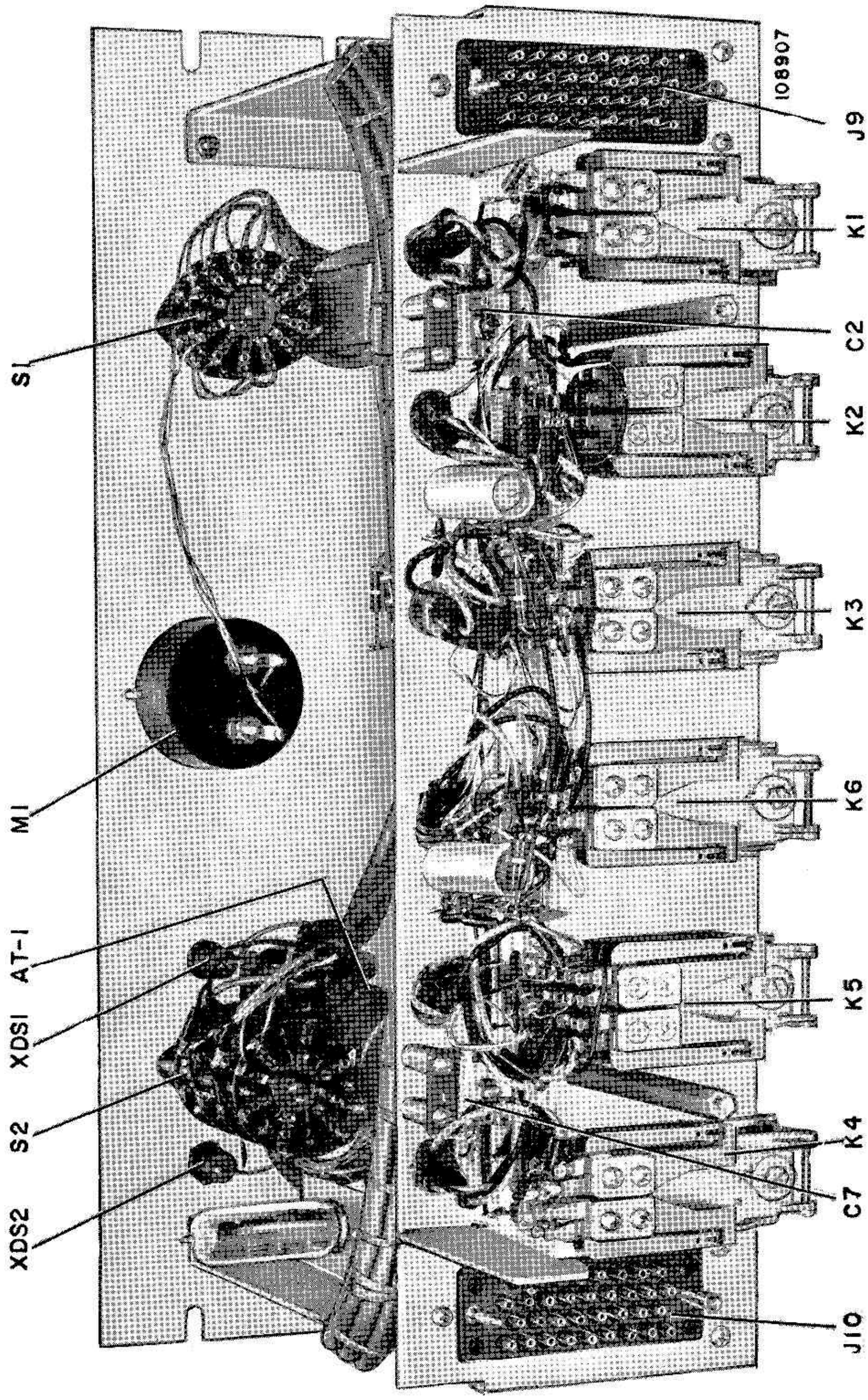


Figure APL-3. Audio Panel, Rear View

Symbol No.	Stock No.	Drawing No.	Description
AUDIO PANEL (8974473-503)			
AT1	218256	8439047-1	Attenuator: 600/600 ohms
			CAPACITORS:
C1A, C1B	102914	458557-16	Electrolytic, 50/50 μf, 50 v
C2	102240	8901210-6	Variable, 50/380 μμf
C3A, C3B	59924	458557-27	Electrolytic, 100/100 μf, 50 v
C4			Not Used
C5	217061	990421-106	Paper, 0.47 μf ±10%, 100 v
C6			Not Used
C7	102240	8901210-6	Variable, 50/380 μμf
C8			Not Used
C9			Not Used
C10	217061	990421-106	Paper, 0.47 μf ±10%, 100 v
C11	219118	990786-275	Plastic, 0.1 μf ±10%, 200 v
DS1, DS2	207238	8890654-2	Lamp: indicator, 28 v
FL1	218257	8439055-1	Filter: high pass
J1	219526	8983883-1	Connector: female, 3 contact
J2	219527	8983883-2	Connector: female, 4 contact
J3	219528	8983883-3	Connector: female, 6 contact
J4	219526	8983883-1	Connector: female, 3 contact
J5	219528	8983883-3	Connector: female, 6 contact
J6	219296	474827-51	Connector: male, 24 contact
J7	213288	8720082-1	Connector: female, 3 contact
J8	219294	8720082-2	Connector: male, 3 contact
J9, J10	219295	474827-50	Connector: male, 34 contact
K1	218259	8872259-28	Relay: 24 v D.C., 4 form "C" contacts
K2	218258	8872259-20	Relay: 24 v D.C., 8 form "C" contacts
K3, K4	218259	8872259-28	Relay: 24 v D.C., 4 form "C" contacts
K5	218258	8872259-20	Relay: 24 v D.C., 8 form "C" contacts
K6	218259	8872259-28	Relay: 24 v D.C., 4 form "C" contacts
M1	218260	484363-8	Meter: 0-3 v D.C.
P1	219562	8983883-10	Connector: male, 3 contact
P2	219563	8983883-1	Connector: male, 4 contact
P3	219564	8983883-12	Connector: male, 6 contact
P4	219562	8983883-10	Connector: male, 3 contact
P5	219564	8983883-12	Connector: male, 6 contact
P6	219530	474827-53	Connector: female, 24 contact
P7	219532	8720082-3	Connector: male 3 contact
P8	52806A	8720082-6	Connector: female, 3 contact
P9, P10	219531	474827-62	Connector: female, 34 contact
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1		82283-154	620 ohm ±5%, ½ w
R2		90496-135	100 ohm ±5%, 1 w
R3			Not Used
R4		90496-62	1000 ohm ±10%, 1 w
R5		82283-74	10,000 ohm ±10%, ½ w
R6		82283-154	620 ohm ±5%, ½ w
R7		90496-135	100 ohm ±5%, 1 w
R8		90496-62	1000 ohm ±10%, 1 w
R9 to R11		82283-154	620 ohm ±5%, ½ w
R12		82283-68	3300 ohm ±10%, ½ w
R13			Not Used
R14		82283-74	10,000 ohm ±10%, ½ w
R15, R16		90496-46	47 ohm ±10%, 1 w
R17		82283-154	620 ohm ±5%, ½ w
S1	218261	8439064-1	Switch: rotary, 2 sec., 12 position
S2	218262	8439062-1	Switch: rotary, 4 sec, 3 position
S3	218263	8978063-1	Switch: flasher, SPST 28 v
XDS1, XDS2		8943520-83	Socket: lamp
	210554		Socket only
	217205		Jewel only
XS1, XS2			Not Used
XS3	94926	737870-14	Socket: for S3
			Miscellaneous:
	30075	712336-507	Knob: for AT1, S1, S2

NOTES

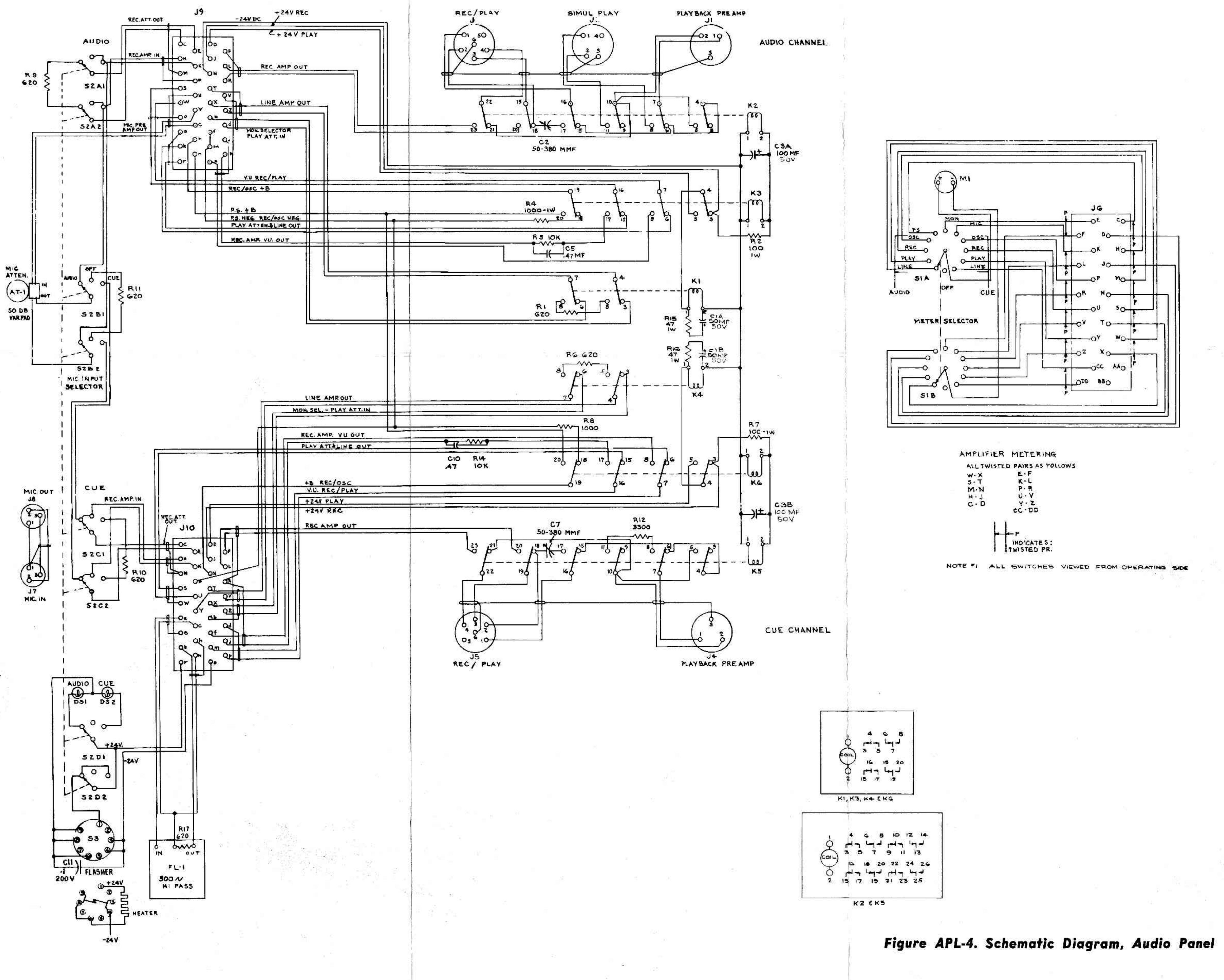
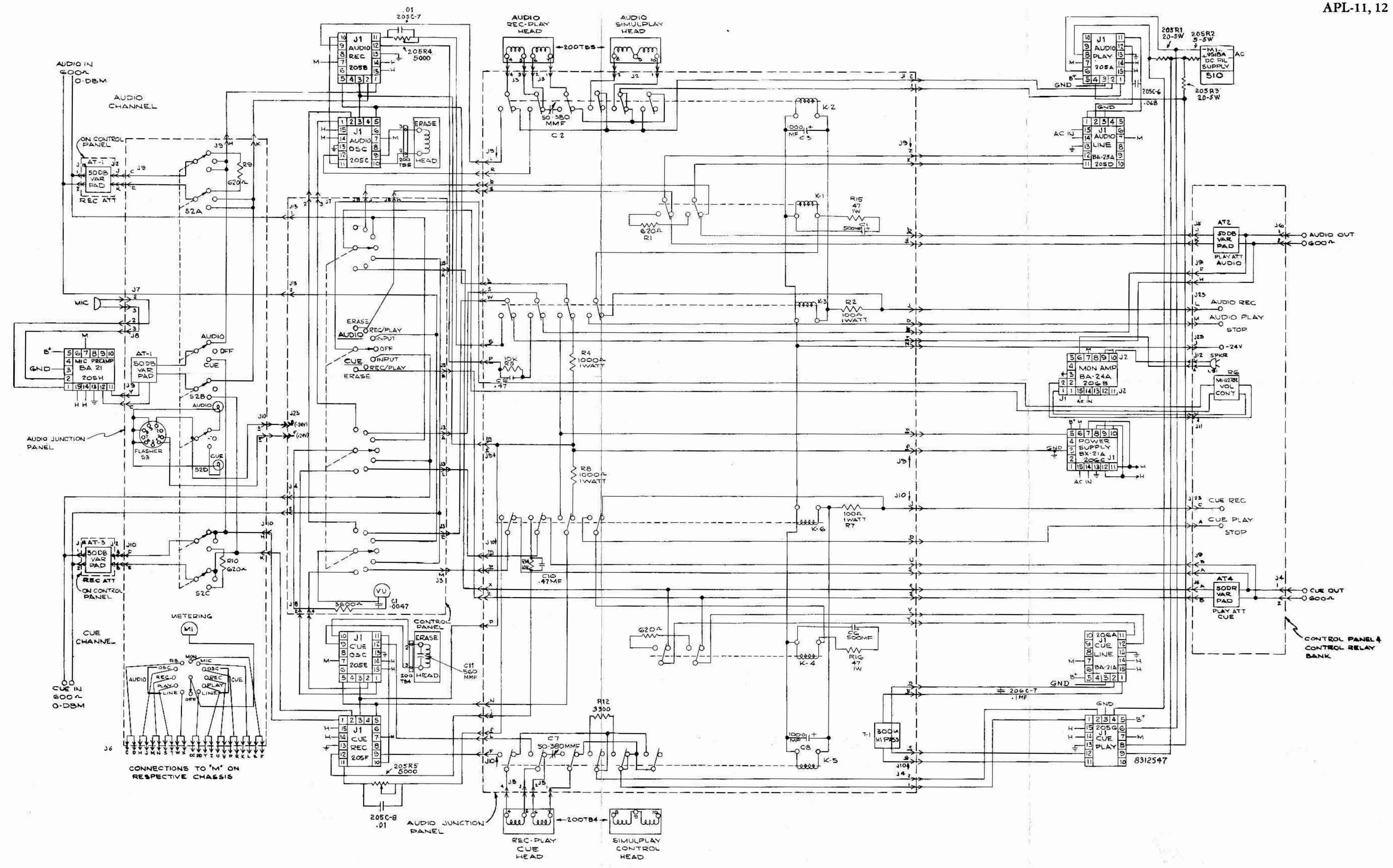


Figure APL-4. Schematic Diagram, Audio Panel



ALL CABLES 2 CONDUCTOR SHIELDED
ALL RELAYS SHOWN IN PLAY POSITION

H - HEATERS
M - METERING
GND - CHASSIS GROUND BUS
⏚ - SYSTEM GROUND

Figure APL-5. Audio System Schematic

Audio/Cue Playback Preamplifier

UNITS 205-A, 205-G

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
DU 671

IB-31115

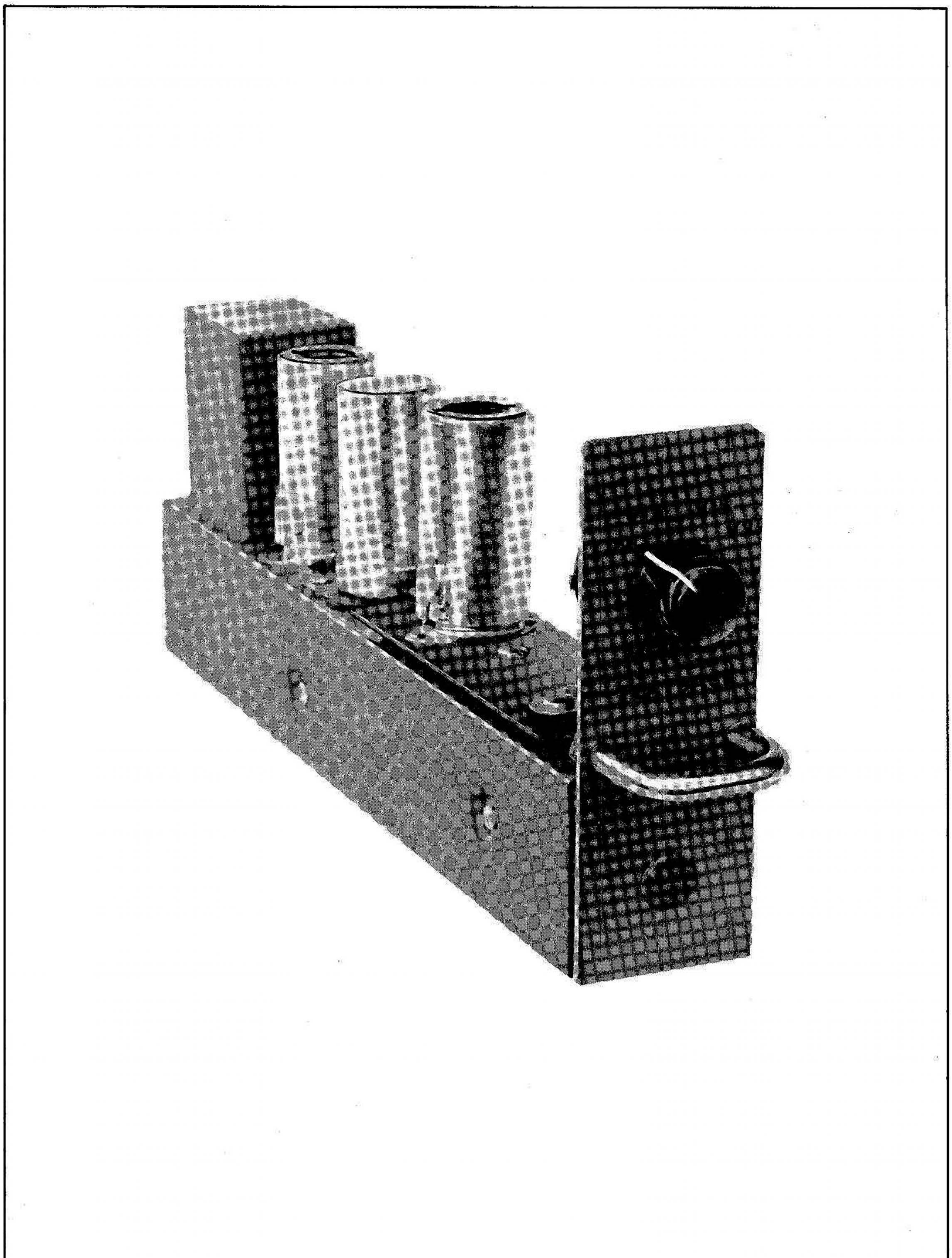


Figure APB-1—Audio Playback Preamplifier

TECHNICAL DATA

Power Required

Plate: 285 volts dc, 10 ma
(from BX-21A Power Supply, Unit 206C)

Heater: V1, 6.3 volts, 0.35 amps dc from Unit 510, 6 volt dc supply
V2, 6.3 volts, 0.3 amps ac from Unit 206C, BX-21A Power Supply

Input

High impedance input connected to magnetic head

Load Impedance

600 ohms balanced: at Unit 205D, Audio Line Amplifier

600 ohms: at 300 cycle high pass filter in Audio Panel, unit 204

Maximum Input Level

—22 dbm

Gain

19 db ±2 db, Audio channel
33 db ±2 db, Cue channel

Frequency Response

Audio: see *Audio System* section
Cue: see *Audio System* section

Hum and Noise Level

—70 dbm maximum

Tube Metering Voltage

1.0 volt ±0.15 volt

Mounting

Plug-in to Audio Shelf, Unit 205

Tube Complement

1 RCA 6072
1 RCA 12AY7

DESCRIPTION

The Playback Preamplifier (see figure APB-1) is used to amplify an input audio frequency signal, from a playback head, to drive a line amplifier. Two identical playback preamplifiers are used in the tape recorder, one for the audio channel (unit 205A) and the other for the cue channel (unit 205G). Besides the playback function, the audio preamplifier obtains a signal, in the record mode, from the simultaneous audio head for monitoring purposes.

The playback preamplifiers (audio and cue) are plug-in mounted on audio shelf unit 205.

Circuit

The playback preamplifiers (see schematic, figure APB-3) contains an input amplifier (V1A) a phase splitter (V1B) and a push-pull output stage (V2). The input signal is fed single-ended from pins 1 and 2 of Plug P1.

The plate circuit of V1A contains r-c filtering which affects the frequency response curve. In the audio playback preamplifier, R19 is in series with the parallel combination of capacitors C17 and C8. Capacitor C17 is placed in parallel with C8 by a jumper between pins 10 and 3 on J1 (the connector at the rear of the shelf). This connection is not made for the cue preamplifier so R19 is in series with C8 only. These connections provide a different response for the audio and cue channels. The audio channel response conforms to the standard NAB audio playback curve. See the section on *Audio Systems* for curves of playback response.

The audio output is fed thru T1, which provides the proper match for a 600 ohm load. The audio output feeds the BA-23 Line Amplifier, while the cue output goes to the 300 cycle cue filter before going to the BA21 amplifier.

Metering switch S1 makes it possible to obtain a relative indication of tube performance by monitoring the voltage across a resistor in each cathode circuit (see *Maintenance*).

A voltage of 6.3 volts dc is supplied to the filaments of V1 (6072) by the dc filament supply unit 510. The ac filament voltages for V2 and all plate supply voltages come from the BX-21A power supply unit 206C.

MAINTENANCE

NOTE: The audio and cue playback preamplifiers are identical, therefore they are directly interchangeable. One may be substituted for the other at any time.

Tube Metering

To obtain a relative indication of tube performance in either the audio or cue playback preamplifiers, rotate the meter SEL switch on the audio junction panel (unit 204) to the AUDIO PLAY or CUE PLAY position. Rotate METERING switch on the corresponding unit to each of its three positions (V1A, V1B,

V2) and note panel meter reading. The normal reading is one (1) volt. Variations exceeding 0.15 volt indicate a departure from normal tube characteristics which may be caused by defect or aging.

Replacement of Components on Printed Circuit Board

If it becomes necessary to change components on the printed circuit board, cut the leads of the component being removed; but, leave enough of the old leads attached to the board so that the replacement part may be soldered to them. Refer to figure APB-2 for component location.

Voltage Readings

The voltage chart in figure APB-3 lists typical tube-socket voltages with respect to ground, measured with a 20,000 ohms-per-volt meter. Values are approximate and may vary $\pm 10\%$ because of normal component tolerances.

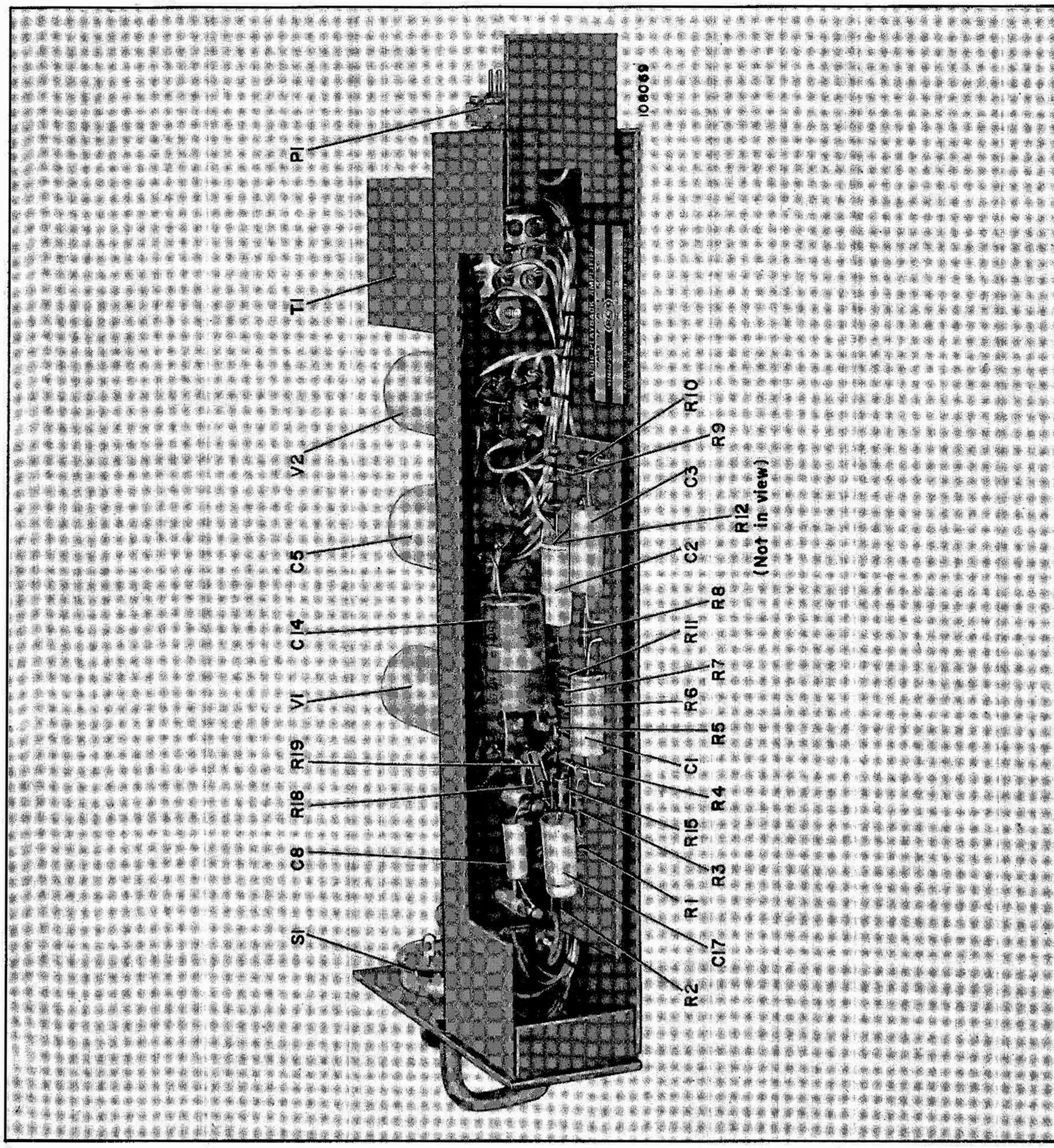


Figure APB-2—Audio Playback Preamplifier, Rear View

LIST OF PARTS

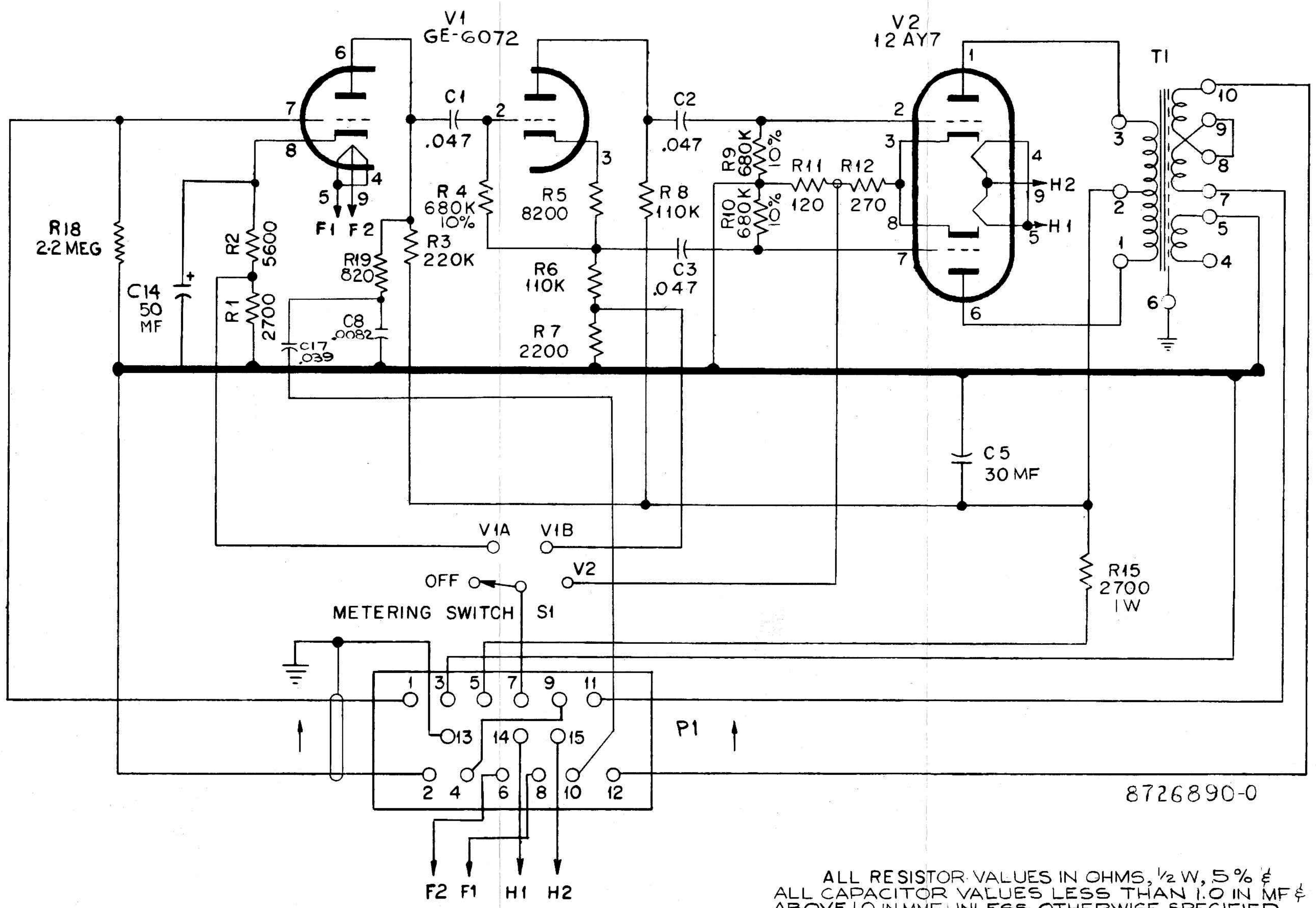
Symbol No.	Stock No.	Drawing No.	Description
			PREAMPLIFIER - PLAYBACK (8974482-504)
			CAPACITORS:
C1 to C3		990786-371	film, 0.047 μf ±10%, 400 v
C4			Not Used
C5	97480	95695-52	Electrolytic, 30 μf -10 +50%, 350 v
C6, C7			Not Used
C8		990786-362	Film, 0.0082 μf ±10%, 400 v
C9 to C13			Not Used
C14	94667	442901-148	Electrolytic, 50 μf -10 +250%, 25 v
C15, C16			Not Used
C17		990786-370	Film, 0.039 μf ±10%, 400 v
P1	205330	459622-1	Connector: male, 15 cont, chassis mtg.
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1		82283-169	2700 ohm ±5%, ½ w
R2		90496-177	5600 ohm ±5%, 1 w
R3		82283-215	220,000 ohm ±5%, ½ w
R4		82283-96	680,000 ohm ±10%, ½ w
R5		82283-181	8200 ohm ±5%, ½ w
R6		82283-208	110,000 ohm ±5%, ½ w
R7		82283-167	2200 ohm ±5%, ½ w
R8		82283-208	110,000 ohm ±5%, ½ w
R9, R10		82283-96	680,000 ohm ±10%, ½ w
R11		82283-137	120 ohm ±5%, ½ w
R12		82283-145	270 ohm ±5%, ½ w
R13, R14			Not Used
R15		90496-169	2700 ohm ±5%, 1 w
R16, R17			Not Used
R18		82283-239	2.2 meg ±5%, ½ w
R19		82283-157	820 ohm ±5%, ½ w
S1	30155	8854922-2	Switch: metering
T1	204325	949721-1	Transformer: output
V2	MI-11299		Tube: selected 12AY7
XV1, XV2	94880	737870-17	Socket: tube, 9 pin
			Miscellaneous:
	205327	8872221-18	Button: plug
	37396	65415-10	Grommet: plate mtg.
	205329	741622-501	Knob: for S1
	28452	85558-2	Plate: mounting for C5
	206512	8978013-504	Printed Board: complete with components
	209283	8827557-5	Screw: shoulder for P1
	56359	8858642-3	Shield: tube
	218170	486041-15	Terminal: insulated stand-off

NOTES

VOLTAGE CHART

	Socket Pins								
	1	2	3	4	5	6	7	8	9
Tube V1	205	—	55	6.3 dc	6.3 dc	160	0	3.4	0
Tube V2	250	0	3.0	*35 dc (approx)	*35 dc (approx)	250	0	3.0	*35 dc (approx)

* 6.3 volts ac between pin 9 and either of pins 4 or 5.



ALL RESISTOR VALUES IN OHMS, ½ W, 5 % &
ALL CAPACITOR VALUES LESS THAN 1.0 IN MF &
ABOVE 1.0 IN MMF UNLESS OTHERWISE SPECIFIED.

Figure APB-3—Schematic Diagram, Audio Playback Preamplifier

Audio/Cue Record Amplifier

UNITS 205-B, 205-F

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31116

PRINTED IN U.S.A.
WA 650

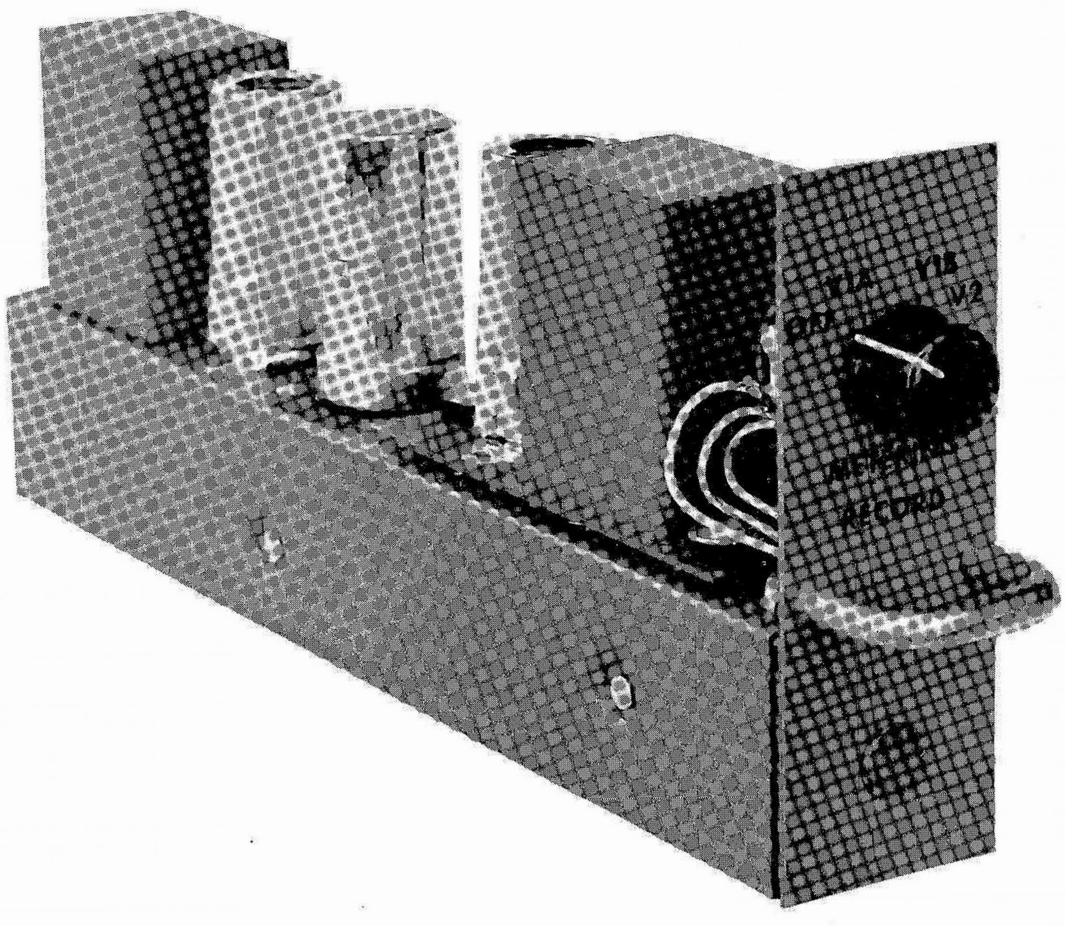


Figure ARA-1. Audio/Cue Record Amplifier

TECHNICAL DATA

Power Required (from BX-21A Power Supply, Unit 206-C)

Plate: 285 volts dc, 10 ma
Heater: 6.3 volts ac, 0.6 amperes

Source Impedance

600 ohm balanced or unbalanced

Input Impedance

Matching: Input transformer unloaded; input impedance higher than source impedance for all frequencies from 30 cps to 15,000 cps.

Output Impedance

Approximately 100 ohms

Maximum Input Level

−22 dbm ±1 db

Maximum Output Level

+18 dbm

Total RMS Harmonic Distortion

(at +18 dbm output)
0.75% rms at 30 cps
0.50% rms from 50 to 15,000 cps

Insertion Gain

40 db ±1 db at 1000 cps

Feedback

20 db at 1000 cps

Frequency Response

See *Audio System* Section

Hum and Noise Level

−70 dbm (max) 600 ohm load

Tube Complement

1 MI-11299 (selected 12AY7)*
1 12AY7

* The RCA selected 12AY7 (MI-11299) is inserted in the socket nearest the front panel (XV1).

DESCRIPTION

The Audio (or Cue) Record Amplifier (see figure ARA-1) is used to amplify an input audio signal which drives the audio (or cue) recording head. The tape recorder uses two identical record amplifiers; one in the audio channel, unit 205-B, and the other in the cue channel, unit 205-F, to provide 40 db of gain (at 1000 cps). These plug-in units are located on the audio shelf, unit 205, which is below the audio panel in rack 2. The input signal (audio or cue) to the record amplifier may originate from the input line or from a local microphone input.

Circuit

The record amplifier (see schematic diagram, figure ARA-3) consists of an input amplifier, V1A, a phase splitter, V1B, and a push-pull output stage V2. Tube V1 is a 12AY7 selected for low noise.

Input transformer T1 is connected for a source impedance of 600 ohms balanced or unbalanced. The RC network, R26 and C15, across the secondary, provides a small amount of low frequency boost.

The two secondary windings of T2 are connected in series to provide the drive required for the recording head circuitry (which includes the bias oscillator secondary). A network consisting of R22, 15K, and C10, is in the high side of the secondary. Resistor R22, 15K, provides the head with a constant current drive. Capacitor C10, 820 $\mu\mu$f, is a bypass around R22 for the bias frequency; C10 also provides a slight amount of high frequency boost.

The low side of transformer T2 (terminal 7) is brought out to pin 8 of P1 and then is returned to ground, pin 10, through a 10 ohm resistor, R21. Since the record head current passes through R21, this is a convenient place to measure the frequency response and the gain of the audio (cue) record system. Capacitor C11 (.01 μf) across the secondary provides a high frequency by-pass for the bias frequency.

The high side of the secondary of T2 (terminal 10) and the high side of the tertiary winding (terminal 4) are connected to pins 11 and 12 of P1. The output at these pins is fed to the VU meter switch on the control panel for monitoring the level of the audio (cue) record signal.

The tertiary winding on T2 supplies negative feedback (20 db at 1000 cps) through a resistance capacitance network (R13, R4, C4) to the cathode of V1A. The feedback improves frequency response, reduces harmonic distortion, and stabilizes the amplifier gain.

Provision is made to obtain a relative indication of tube performance by monitoring the voltage across a resistor in each cathode circuit. METERING switch S1 selects the tube to be checked (see *Maintenance*).

Plate and filament voltages are supplied to the unit by the BX-21A Power Supply (unit 206-C) through plug P1 pins 14 and 15.

MAINTENANCE

NOTE: Since the audio and cue record amplifiers are identical, one may be substituted for the other when trouble shooting the audio or cue channel.

Tube Metering

To obtain a relative indication of tube performance in either record amplifier, rotate METER SEL switch on the audio junction panel (unit 204) to AUDIO or CUE REC position. Rotate METERING switch, on the corresponding record amplifier, to each of its three positions (V1A, V1B, V2) and note panel meter reading. The normal reading is one volt. Variations exceeding 0.15 volt indicate a departure from normal tube characteristics which may be caused by defect or aging.

Replacement of Components on Printed Circuit Board

If it becomes necessary to change components on the printed circuit board, cut the leads of the component being removed, but leave enough of the old leads attached to the board so that the replacement part may be soldered to them. Refer to figure ARA-2 for component location.

Frequency Response

The frequency response is covered in the *Audio System* section; the response includes the audio record amplifier, audio heads, bias secondary and other associated circuits.

Voltage Readings

The voltage chart in figure ARA-3 lists typical tube-socket voltages with respect to ground, measured with 20,000 ohms-per-volt meter. Values are approximate and may vary ±10% because of normal component tolerances.

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			AMPLIFIER - RECORD (8974482-503)
			CAPACITORS:
C1 to C3		990786-371	film, 0.047 μf ±10%, 400 v
C4		990786-265	film, 0.015 μf ±10%, 200 v
C5	97480	95695-52	electrolytic, 30 μf -10 +50%, 350 v
C6 to C9			Not Used
C10		727863-145	mica, 820 μμf ±10%, 500 v, char "D"
C11		735715-163	paper, 0.01 μf ±10%, 400 v
C12 to C14			Not Used
C15		735715-165	paper, 0.015 μf ±10%, 400 v
P1	205330	459622-1	Connector: male, 15 cont, chassis mtg.
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1		82283-169	2700 ohm ±5%, ½ w
R2		90496-177	5600 ohm ±5%, 1 w
R3		82283-215	220,000 ohm ±5%, ½ w
R4		82283-96	680,000 ohm ±10%, ½ w
R5		82283-181	8200 ohm ±5%, ½ w
R6		82283-208	110,000 ohm, ±5%, ½ w
R7		82283-167	2200 ohm ±5%, ½ w
R8		82283-208	110,000 ohm ±5%, ½ w
R9, R10		82283-96	680,000 ohm ±10%, ½ w
R11		82283-137	120 ohm ±5%, ½ w
R12		82283-145	270 ohm ±5%, ½ w
R13		82283-191	22,000 ohm ±5%, ½ w
R14		82283-211	150,000 ohm ±5%, ½ w
R15		90496-169	2700 ohm ±5%, 1 w
R16 to R20			Not Used
R21		82283-111	10 ohm ±5%, ½ w
R22		82283-187	15,000 ohm ±5%, ½ w
R23 to R25			Not Used

Symbol No.	Stock No.	Drawing No.	Description
R26		82283-207	100,000 ohm ±5%, ½ w
S1	30155	8854922-2	Switch: metering
T1	205326	949720-1	Transformer: input
T2	205325	949721-1	Transformer: output
V1, V2	MI-11299		Tube: selected 12AY7
XV1, XV2	94880	737870-17	Socket: tube, 9 pin
			Miscellaneous:
	206512	8978013-503	Printed Board: complete with components
	56359	8858642-3	Shield: tube
	218170	486041-15	Terminal: insulated stand-off
	205327	8872221-18	Button: plug
	37396	65415-10	Grommet: plate mtg.
	205329	741622-501	Knob: for S1
	28452	85558-2	Plate: mounting for C5
	309283	8827557-5	Screw: shoulder for P1

NOTES

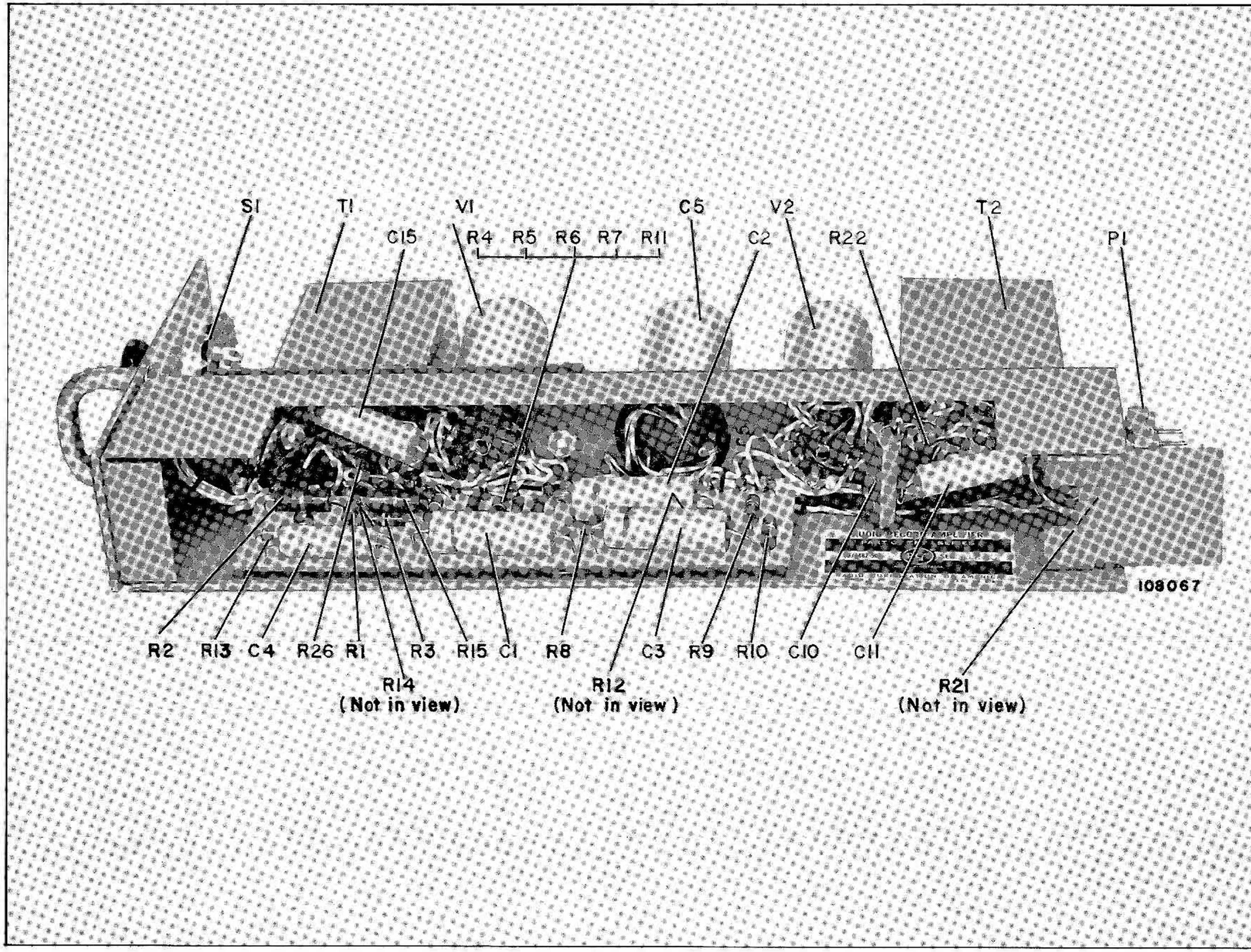
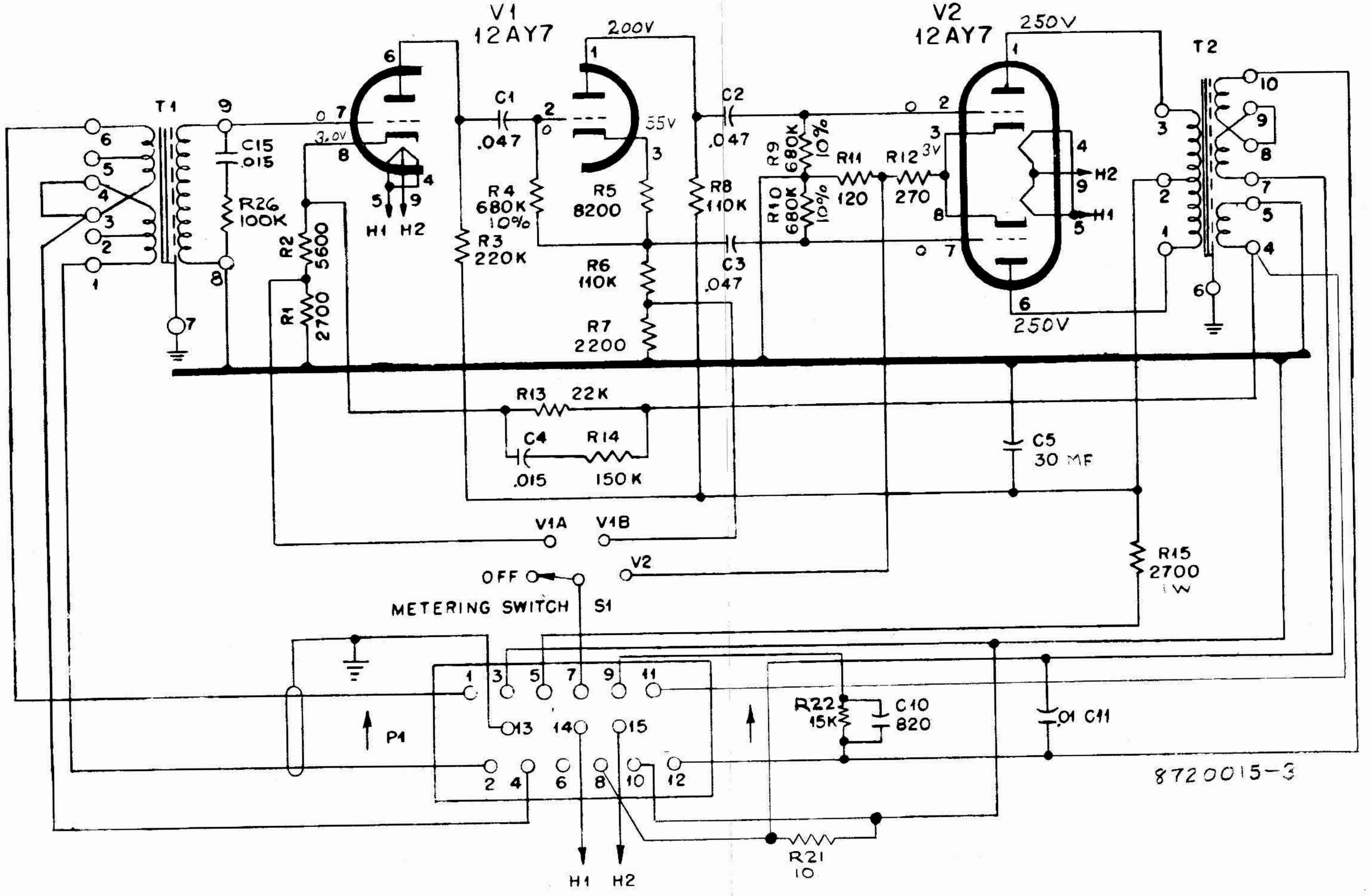


Figure ARA-2. Audio/Cue Record Amplifier, Bottom View

VOLTAGE CHART

	Socket Pins								
Symbol	1	2	3	4	5	6	7	8	9
Tube V1	200	—	55	*35 dc (approx.)	*35 dc (approx.)	148	0	3.0	*35 dc (approx.)
Tube V2	250	0	3.0	*35 dc (approx.)	*35 dc (approx.)	250	0	3.0	*35 dc (approx.)

* 6.3 volts ac between terminals 4 - 5 and 9.



ALL RESISTANCES IN OHMS AND ½ W, 5% &
ALL CAPACITANCES LESS THAN 1.0 IN MF & ABOVE 1.0 IN MMF
UNLESS OTHERWISE INDICATED

TRANSFORMER CONNECTIONS		
IMPEDANCE	INPUT — T1	OUTPUT — T2
37.5 OHMS	1-5, 2-6	———
600 OHMS	3-4, 3CT	8-9

Figure ARA-3. Audio/Cue Record Amplifier, Schematic Diagram

Audio/Cue Oscillator

UNITS 205-C, 205-E

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31117

PRINTED IN U.S.A.
WA 660

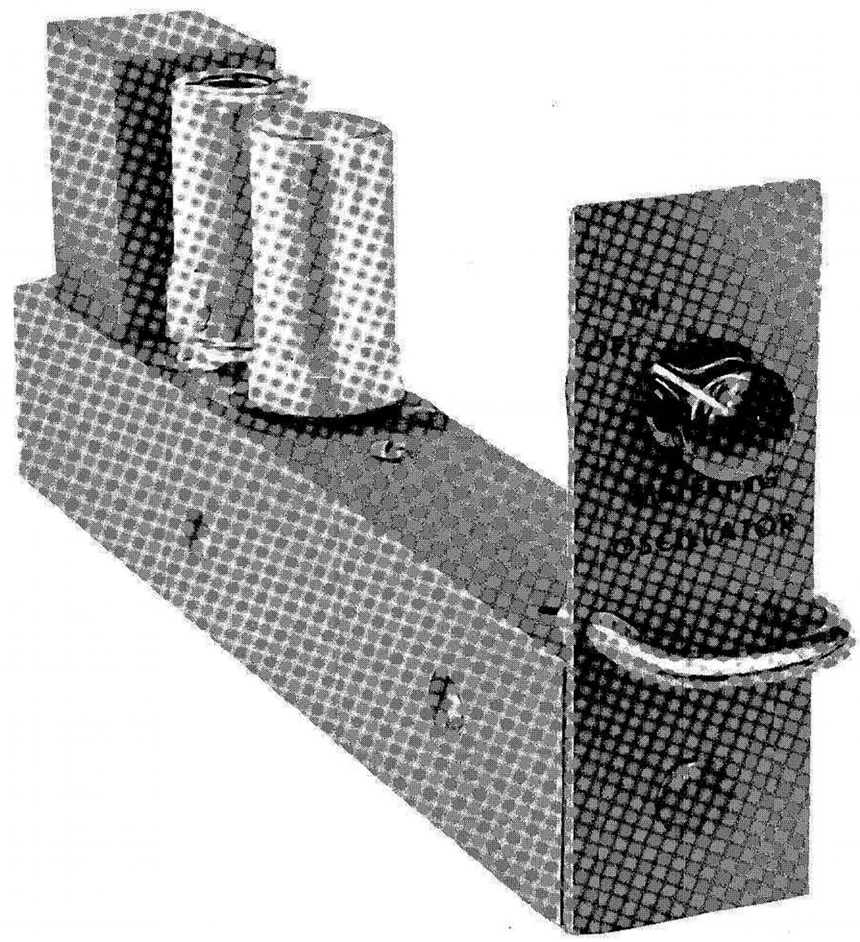


Figure OSC-1. Audio/Cue Oscillator

TECHNICAL DATA

Power Required

Plate: 285 volts dc, 20 ma
(from BX-21A Power Supply, unit 206-C)
Heater: 6.3 volts ac, 0.3 ampere

Tube Metering Voltage

1.0 volt ±0.15 volt

Outputs

Audio Oscillator: 55 KC bias for audio Record/Play head
Erase current for audio head

Cue Oscillator: 40 KC bias for cue Record/Play head
Erase current for cue head

Mounting

Plug-in, on MI-11597 Mounting Shelf (unit 205)

Tube Complement

1 12AU7

DESCRIPTION

Two identical plug-in oscillator units (see figure OSC-1) are used in the TRT-1B Tape Recorder; one unit, 205-C is used in the audio channel and the other, 205-E, is used in the cue channel. These units are mounted on the audio shelf (unit 205) in rack 2.

The purpose of the oscillators is to provide erase current to the erase heads, and signal bias for the record heads. The audio oscillator frequency is 55 KC and the cue oscillator frequency is 40 KC. External modifications are made to the cue oscillator to reduce the frequency and the output to the cue channel.

Circuit

The oscillator (see schematic diagram figure OSC-3) consists of a push-pull oscillator circuit using a dual triode. The plates of the triodes are ac coupled to the erase head through pins 9 and 10 of plug P1. The inductance of the erase head forms a tuned circuit with a shunt capacitor. In the audio channel, this shunt capacitor C7, 270 $\mu\mu$f, is used to obtain a resonant frequency of 55 KC. In the cue channel, C7 is shunted with C11, 560 $\mu\mu$f, which is on TB4 of the tape transport panel, and this results in a frequency of 40 KC.

Positive feedback for oscillation is obtained by coupling a portion of the energy from each plate back to the opposite grids through a resistor-divider network. The network consists of R16, 47K, and R6, 110K, for one half, and R17, 47K and R8, 110K, for the other half.

Transformer T1 is used to couple the erase frequency into the record circuitry for signal bias. The secondary of T1 is connected to pins 11 and 12 of P1. In the system wiring, the secondary is placed in series with the recording head.

NOTE: In the record circuitry, one winding of the record head is used to form an absorption trap. An adjustable capacitor (C2 audio, or C7 cue, in the audio panel) is used to vary the amount of the bias signal coupled into the record head. This adjustment is covered in the *Audio System* section.

A peak-to-peak detector circuit (CR1, CR2, etc.) is connected across the secondary of T1. The output of the detector circuit is fed to pins 1 and 2 of P1 where connection is made to the VU meter switch (S1) for monitoring purposes. With switch S1 in the ERASE position, for either audio or cue, the VU meter should read, for normal operation, 0 ±1 db for audio and −4 ±1 db for cue.

As stated above, the oscillator unit in the audio channel and the oscillator used in the cue channel are alike. The audio oscillator has a B+ voltage of 285 volts which is received through pin 5 of plug P1; however, the oscillator for the cue channel receives its B+ voltage from pin 4 of plug P1. This connects R27, a 3300 ohm dropping resistor, in series with the B+ voltage thus reducing the cue erase current to the desired level.

The METERING SWITCH S1, is used to obtain a relative indication of tube performance. This switch monitors a voltage across a resistor in the cathode circuit. With the METER SEL switch on the audio junction panel, unit 204, rotated to AUDIO OSC or CUE OSC, and S1 set to V1, the normal meter indication is 1 volt ±.15 volt.

MAINTENANCE

NOTE: Since the audio and cue oscillators are identical, one may be substituted for the other when trouble shooting the audio or cue channel. Refer to figure OSC-2 for location of components.

Voltage Readings

The table in figure OSC-3, indicates typical tube socket voltages with respect to ground, measured with a 20,000 ohm-per-volt meter. Values are approximate and may vary ±10% because of the normal component tolerances.

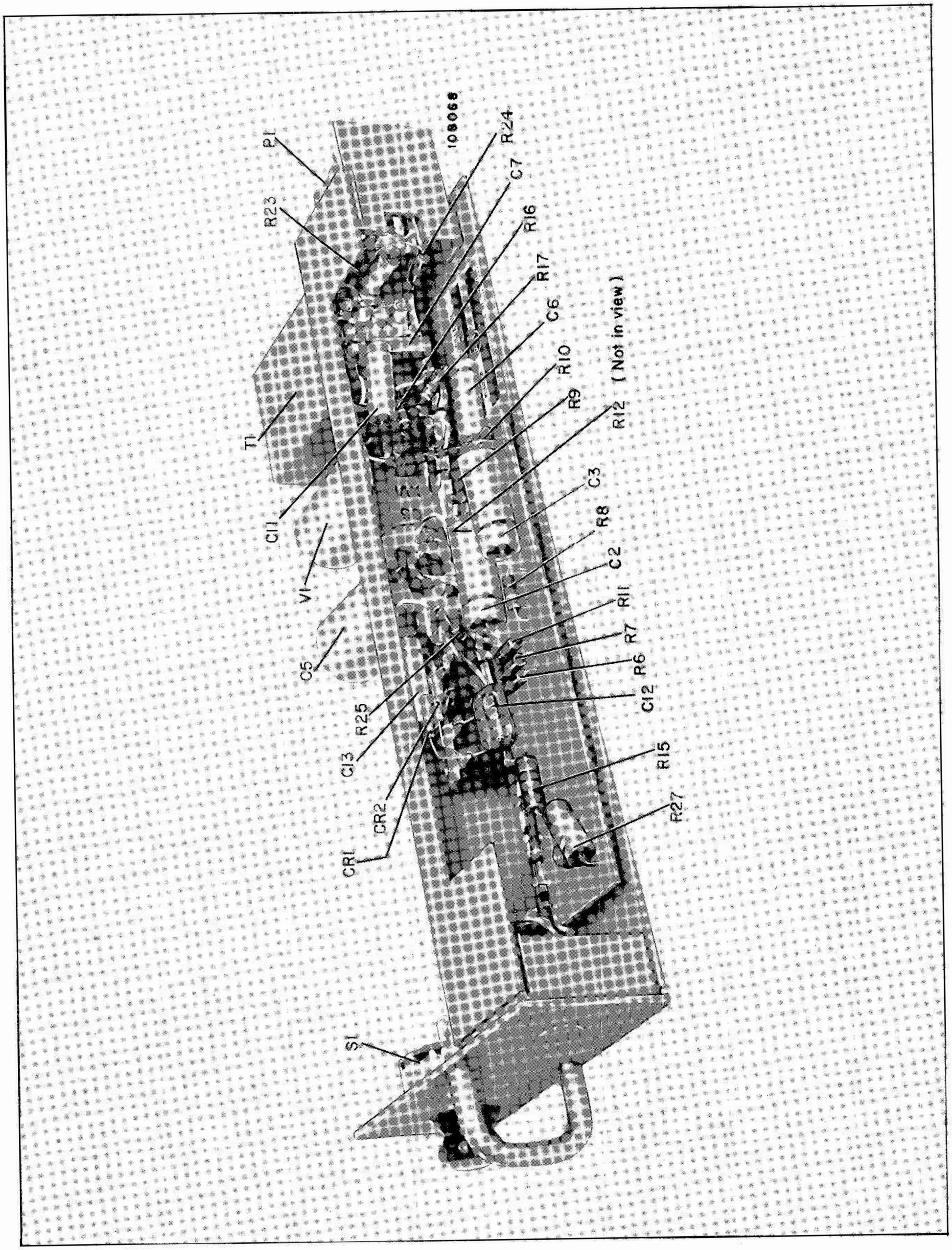


Figure OSC-2. Audio/Cue Oscillator, Bottom View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
OSCILLATOR (8974482-501)			
			CAPACITORS:
C1			Not Used
C2, C3		990786-371	film, 0.047 μf ±10%, 400 v
C4			Not Used
C5	97480	95695-52	electrolytic, 30 μf -10 +50%, 350 v
C6		735715-163	paper, 0.01 μf ±10%, 400 v
C7		727858-133	mica, 270 μμf ±10%, 500 v char "D"
C8 to C10			Not Used
C11		735715-163	paper, 0.01 μf ±10%, 400 v
C12		8924416-326	mica, 5100 μμf ±5%, 300 v char "F"
C13		735715-163	paper, 0.01 μf ±10%, 400 v
C14	94667	442901-148	electrolytic, 50 μf -10 +250%, 25 v
C15		735715-165	paper, 0.015 μf ±10%, 400 v
CR1, CR2	59395		Diode: Type 1N34A
P1	205330	459622-1	Connector: male, 15 cont., chassis mtg.
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1 to R5			Not Used
R6		82283-208	110,000 ohm ±5%, ½ w
R7		82283-167	2200 ohm ±5%, ½ w
R8		82283-208	110,000 ohm ±5%, ½ w
R9, R10		82283-96	680,000 ohm ±10%, ½ w
R11		82283-137	120 ohm ±5%, ½ w
R12		82283-145	270 ohm ±5%, ½ w
R13, R14			Not Used
R15		90496-169	2700 ohm ±5%, 1 w
R16, R17		82283-199	47,000 ohm ±5%, ½ w
R18 to R22			Not Used
R23		82283-187	15,000 ohm ±5%, ½ w
R24		82283-159	1000 ohm ±5%, ½ w
R25		82283-202	62,000 ohm ±5%, ½ w
R26			Not Used
R27		99126-171	3300 ohm ±5%, 2 w
S1	30155	8854922-2	Switch: metering
T1	205325	949721-1	Transformer: output
XV1	94880	737870-17	Socket: tube, 9 pin
			Miscellaneous:
	205329	741622-501	Knob: for S1
	206512	8978013-501	Printed Board: complete with components
	56359	8858642-3	Shield: tube
	218170	486041-15	Terminal: insulated standoff
	205327	8872221-18	Button: plug
	28452	85558-2	Plate: mounting for C5
	209283	8827557-5	Screw: shoulder for P1

NOTES

OSCILLATOR VOLTAGE CHART

Unit Function	*Symbol*	*Socket Pins*								
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Audio (205-C)	V1	230	—	6.4	*35 dc (approx.)	*35 dc (approx.)	230	—	6.4	*35 dc (approx.)
Cue (205-E)	V1	220	—	7.5	*35 dc (approx.)	*35 dc (approx.)	220	—	7.5	*35 dc (approx.)

*6.3 volts ac between terminals 4 - 5 and 9.

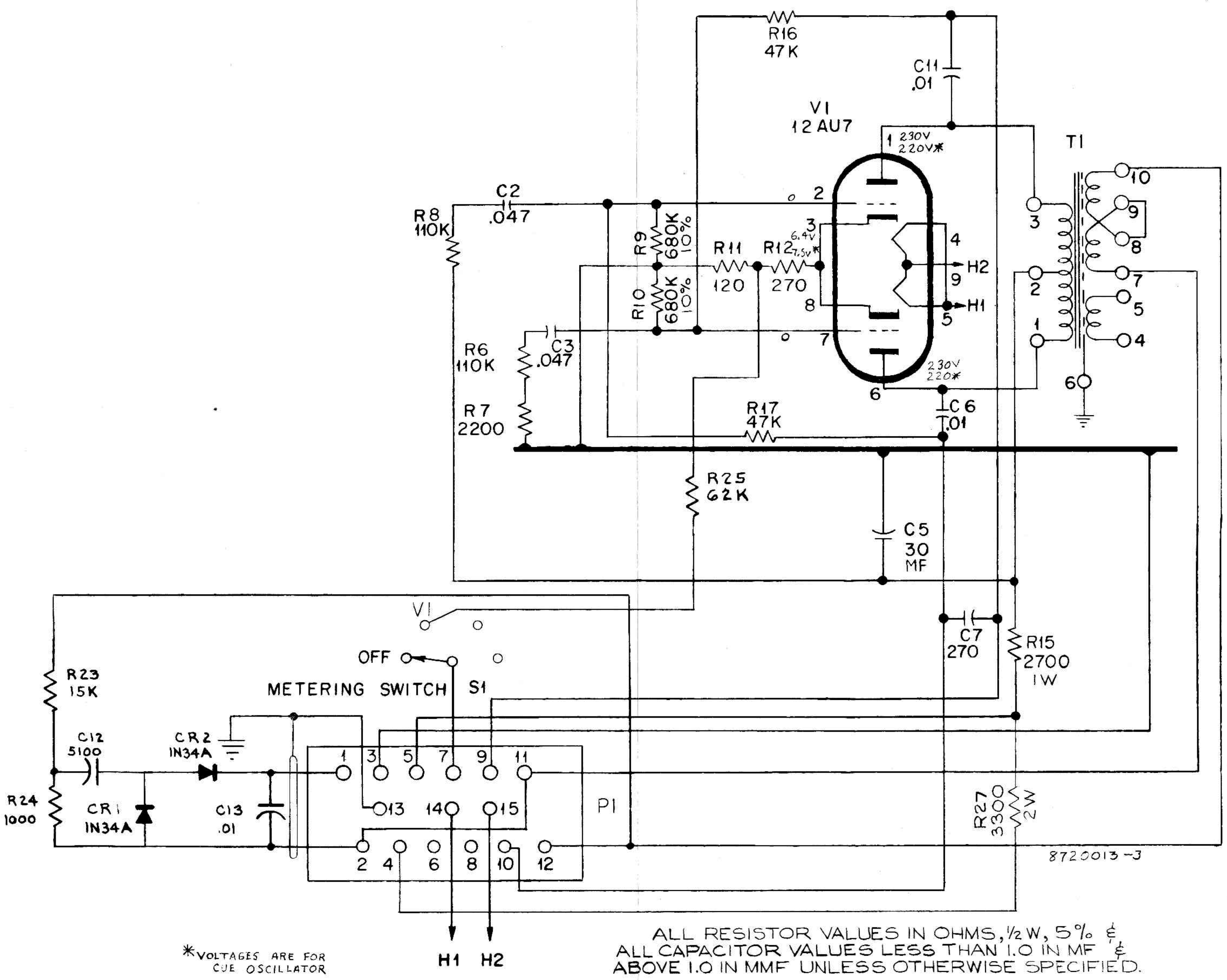


Figure OSC-3. Audio/Cue Oscillator, Schematic Diagram

Program Amplifier

TYPE BA-23A

UNIT 205-D

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
BR-621

IB-31122

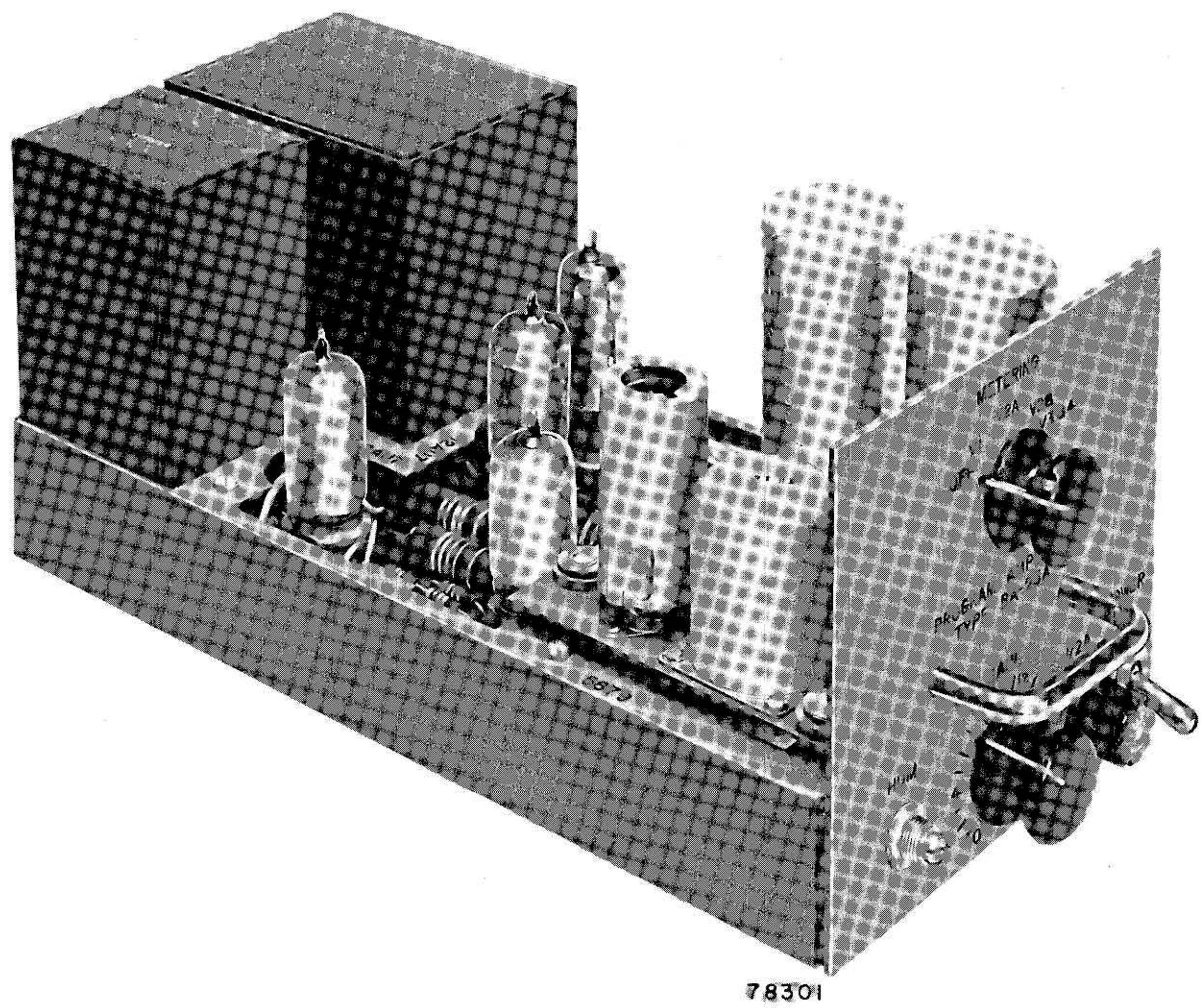


Figure ALA-1. Type BA-23A Program Amplifier

TECHNICAL DATA

Power Required
100 to 130 volts, 50/60 cps, 30 watts

Source Impedance
600 ohms balanced

Input Impedance
600 ohms

Maximum Input Level
−10 dbm

Output Impedance
100 ohms (approximately)

Load Impedance
600 ohms

Harmonic Distortion
0.5% rms maximum at 30 dbm output, 30 to 15,000 cps

Gain
55 ±1 db

Frequency Response
±1 db, 30 to 15,000 cps (see figure ALA-2)

Noise Level
−47 dbm

Tube Complement
1 — MI-11298 (selected RCA 5879)
1 — 12AX7
2 — 12AU7
1 — 6X4

Dimensions and Weight
Length: 10⅜ inches (12½ inches overall)
Height: 4²¹⁄₃₂ inches
Width: 5 inches
Weight: 9 pounds

Finish
Light Umber Gray

DESCRIPTION

The Type BA-23A Program Amplifier (unit 205-D) is a high fidelity, high gain, low distortion amplifier used as the audio line amplifier. Its purpose is to amplify the signal from the audio play preamplifier (unit 205-A).

Controls

Figure ALA-1 shows the controls on the amplifier front panel. These consist of a GAIN control, HUM adjustment, POWER switch, and METERING switch (to permit selective metering of tube currents).

Plug-in Mounting

The amplifier is plug-in mounted on an MI-11597 Mounting Shelf (unit 205). A guide assembly attached to the shelf facilitates insertion and withdrawal of the unit and insures correct mating of plug P1 on the rear of the chassis with receptacle J1 on the shelf.

Terminal connections of P1 are shown in a table on the schematic diagram, figure ALA-5.

Circuit

As shown on the schematic diagram, figure ALA-5, input transformer T1 is tapped for input impedances of 150 and 600 ohms, but is connected for 600 ohms. Attenuator AT1, across the secondary of T1, controls the voltage amplitude at the grid of the low noise pentode V1, and acts as the GAIN control. Both T1 and V1 are on a shock-mounted plate to eliminate microphonics due to vibration.

The amplified output of V1 is resistance-capacitance coupled to V2A. Two terminals (HI and LO) are provided in the grid circuit of V2A which allow adjustment of the grid bias voltage. This adjustment determines a maximum amplifier gain of 55 db (LO), as used in the tape recorder, or 70 db (HI).

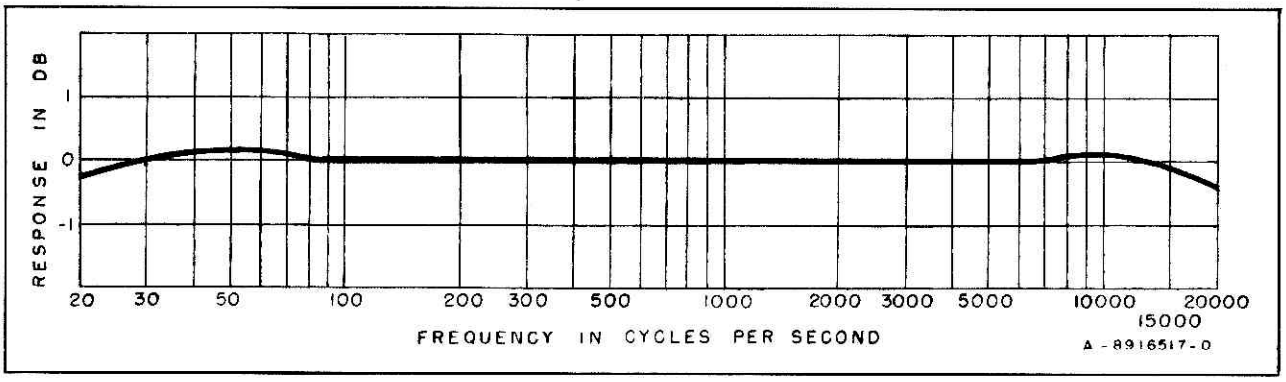


Figure ALA-2. Frequency Response Curve

The second section of V2 (V2B) is used as a phase splitter, feeding signal voltages of equal amplitude and opposite polarity to the grids of twin triodes V3 and V4. These tubes operate as push-pull amplifiers with their sections connected in parallel. The amplified output of V3 and V4 is applied to output transformer T2. The split secondary winding of T2 is connected in series for a 600 ohm load impedance, but may also be connected in parallel for a 150 ohm load impedance.

A tertiary winding on T2 supplies negative feedback through resistor R23 to the cathode of V2A. The feedback improves frequency response (figure ALA-2), reduces harmonic distortion, and stabilizes the amplifier gain.

Provision has been made to obtain a relative indication of tube performance by monitoring the voltage across a resistor in each cathode circuit. METERING switch S1 selects the tube to be checked (see *Maintenance*).

Plate and filament power is supplied to the unit by a self contained power supply consisting of power transformer T3, full-wave rectifier V5, and a resistance-capacitance filtering network (R24, R25, C11A/11B).

ADJUSTMENTS

GAIN Adjustment

Rotate GAIN control to maximum position (clockwise) and set AUDIO PLAY LEVEL attenuator on control panel (unit 305) to 12. Play back a tape having normal audio recorded, and adjust AUDIO PLAY LEVEL attenuator until VU meter (AUDIO/CUE) on control panel peaks at zero.

HUM Adjustment

Adjust HUM control (R28) for minimum hum in the amplifier output using an AC vacuum-tube voltmeter across the AUD LINE OUT connector at the rear of the control panel. Terminate the audio line output with 600 ohms when making this adjustment.

Power Transformer Connections

Power transformer T3 is designed for operation at 105, 115, and 125 volts, 50/60 cycles, but is normally connected for a 115-volt line. If the line voltage is above 120 volts, move the red and black wire from terminal 3 of T3 to terminal 4. If the line voltage is below 110 volts, move the wire from terminal 3 to terminal 2.

MAINTENANCE

Routine Checks

The amplifier should be checked periodically to insure proper operation. This procedure should include removal of dust around components and wiring, and cleaning the connector pins by moving the plug in and out of its receptacle several times.

Tube Metering

To obtain a relative indication of tube performance, rotate METER SEL switch on audio junction panel (unit 204) to AUDIO LINE position. Rotate METERING switch on BA-23A amplifier front panel to each position (V1, V2A, V2B, V3/V4) and note panel meter reading. The normal reading is one volt. Variations exceeding 0.15 volt indicate a departure from normal which may be caused by a defective or aging tube.

Replacement of Components on Printed Circuit Board

Figure ALA-3 shows the components which are mounted on a removable printed circuit board. If it becomes necessary to replace components, follow the procedure outlined in IB-31119 (BA-24A Monitoring Amplifier) after removing the printed circuit board.

Voltage Readings

The *Voltage Table* indicates typical tube-socket voltages with respect to ground measured with a 20,000 ohm-per-volt meter. All voltages are dc unless otherwise noted.

VOLTAGE TABLE

Tube	*Pin*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1	0	NC	5.8 ±0.15	37 ±5	37 ±5	NC	165 ±20	90 ±15	5.6 ±0.8
V2	200 ±20		63 ±7	37 ±5	37 ±5	140 ±14	0	1.25 ±1	37 ±5
V3	280 ±14	0	11.5 ±1	37 ±5	37 ±5	285 ±14	0	11.5 ±1	37 ±5
V4	280 ±14	0	11.5 ±1	37 ±5	37 ±5	285 ±14	0	11.5 ±1	37 ±5
V5	285 ±20 ac	NC	37 ±5	37 ±5	NC	285 ±20 ac	305 ±15	NC	NC

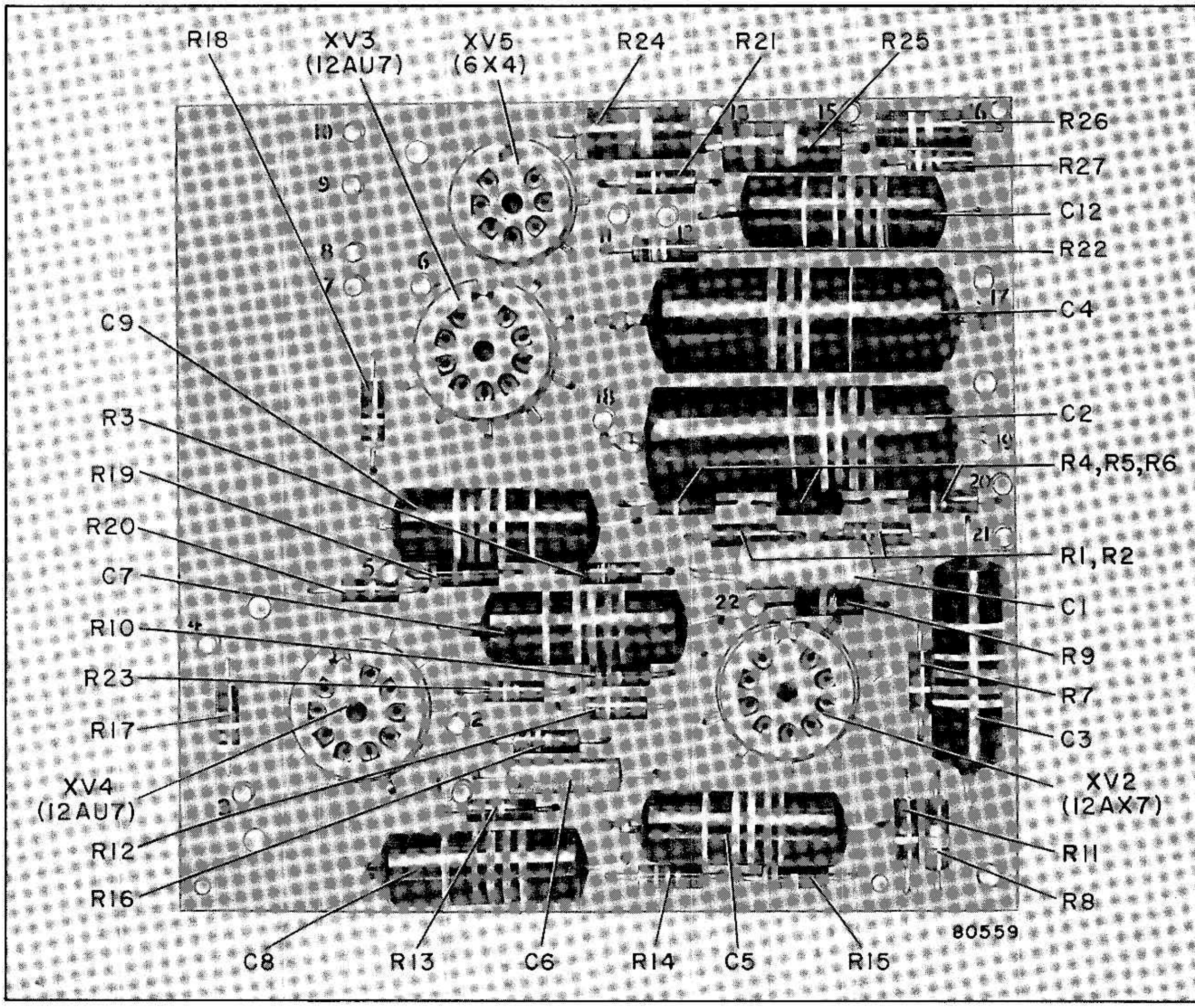


Figure ALA-3. Printed Circuit Board Components

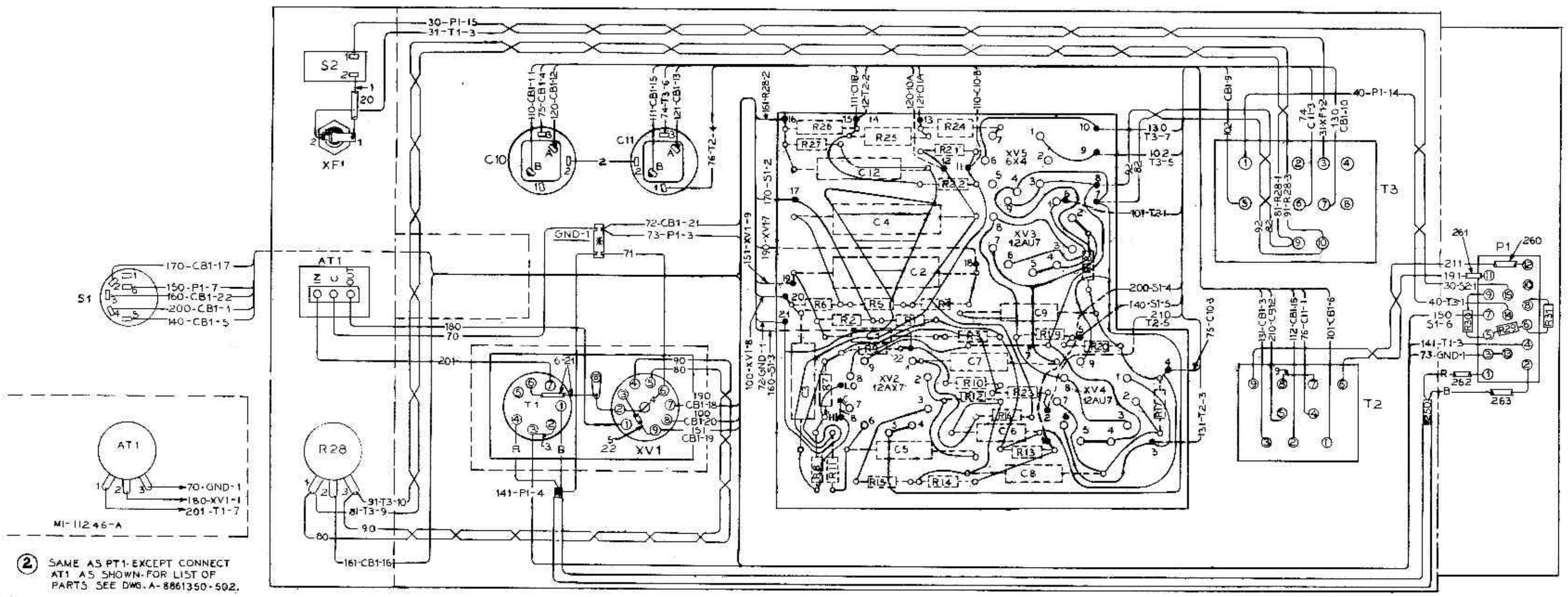
LIST OF PARTS

PROGRAM AMPLIFIER, MI-11246-A

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
AT1	209286	746053-28	Resistor: variable, composition, 100,000 ohm, ±10%, 2 w
			CAPACITORS:
C1		727861-143	mica, 680 μμf ±10%, 400 v, Char "B"
C2		735715-129	paper, 0.22 μf ±20%, 400 v
C3		735715-171	paper, 0.047 μf ±10%, 400 v
C4		735715-31	paper, 0.33 μf ±20%, 200 v
C5		735715-171	paper, 0.047 μf ±10%, 400 v
C6		727853-209	mica, 27 μμf ±10%, 400 v, Char "D"
C7 to C9		735715-171	paper, 0.047 μf ±10%, 400 v
C10A/B, C11A/B	102913	442900-29	electrolytic, 40/40 μf -10 +50%, 450 v
C12		735715-171	paper, 0.047 μf ±10%, 400 v
F1	212327	990157-106	Fuse: ½ amp., 125 v, slo blo type, cartridge
P1	205330	459622-1	Connector - male, 15 contact, chassis mounting

Symbol No.	Stock No.	Drawing No.	Description
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1		735730-153	560 ohm, ±5%, ½ w
R2		735730-169	2700 ohm, ±5%, ½ w
R3		735730-71	5600 ohm, ±10%, ½ w
R4		735730-211	150,000 ohm, ±5%, ½ w
R5		735730-77	18,000 ohm, ±10%, ½ w
R6		735730-205	82,000 ohm, ±5%, ½ w
R7		735730-211	150,000 ohm, ±5%, ½ w
R8		735730-227	680,000 ohm, ±5%, ½ w
R9		735730-163	1500 ohm, ±5%, ½ w
R10		735730-145	270 ohm, ±5%, ½ w
R11		735730-211	150,000 ohm, ±5%, ½ w
R12		735730-96	680,000 ohm, ±10%, ½ w
R13		735730-167	2200 ohm, ±5%, ½ w
R14		735730-209	120,000 ohm, ±5%, ½ w
R15		735730-169	2700 ohm, ±5%, ½ w
R16		735730-209	120,000 ohm, ±5%, ½ w
R17, R18		735730-94	470,000 ohm, ±10%, ½ w
R19		735730-148	360 ohm, ±5%, ½ w
R20		735730-124	36 ohm, ±5%, ½ w
R21		735730-76	15,000 ohm, ±10%, ½ w
R22		735730-74	10,000 ohm, ±10%, ½ w
R23		735730-189	18,000 ohm, ±5%, ½ w
R24		99126-52	150 ohm, ±10%, 2 w
R25		99126-59	560 ohm, ±10%, 2 w
R26		90496-87	120,000 ohm, ±10%, 1 w
R27		735730-77	18,000 ohm, ±10%, ½ w
R28	206037	737801-24	variable, 500 ohm, ±20%, ¼ w
R29		735730-154	620 ohm, ±5%, ½ w
R30, R31		735730-74	10,000 ohm, ±10%, ½ w
S1	209279	8838619-3	Switch - rotary, (wafer type, 1 circuit, 1 section, 5 position, non-shorting contacts)
S2	48791	187454-2	Switch - toggle, (SPST, 3 amp @ 250 v. bat handle
T1	209280	949810-1	Transformer - audio, input
T2	209281	949682-1	Transformer - audio, output
T3	209282	949725-1	Transformer - power
XF1	205914	8811104-1	Holder - fuse
XV1	94880	737870-17	Socket - tube, 9 contact miniature, with shield
XV2, XV3, XV4	209284	8817696-1	Socket - tube, 9 contact miniature
XV5	209285	8817695-1	Socket - tube, 7 contact miniature
	209287	8865162-501	Circuit Board Assembly - (etched circuit board) complete, including C1 to C9, C12, R1 to R27, XV2 to XV5
	205331	459623-1	Connector - female, 15 contact, chassis mounting
	37396	65415-10	Grommet - plate mounting
	30075	712336-507	Knob
	18469	85558-3	Plate - mounting, for C10, C11
	209283	8827557-5	Screw - shoulder, for P1
	56359	8858642-3	Shield - tube

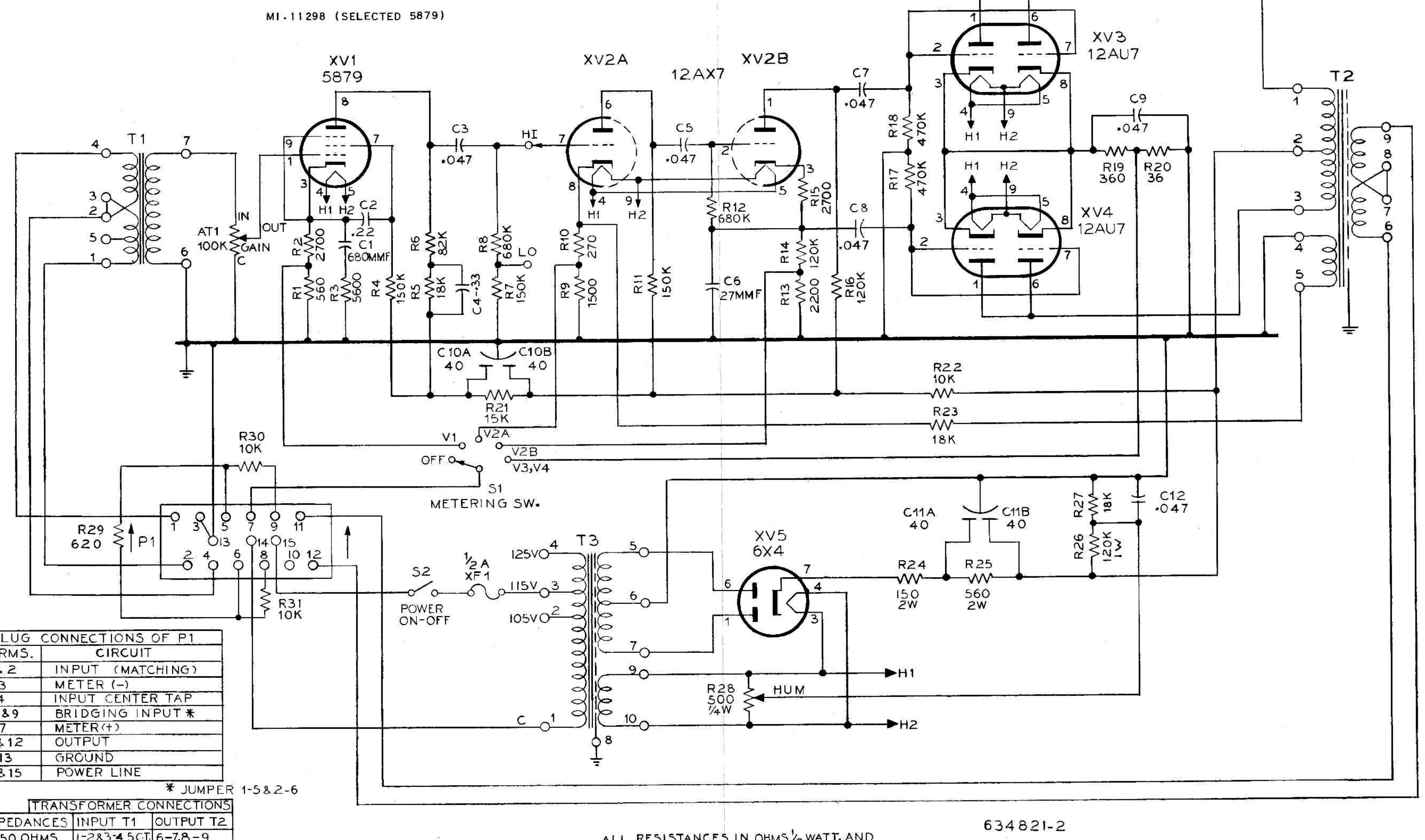
WIRE TABLE			
WIRE NO. INCLUSIVE	DESCRIPTION	P.S. OR DWG. NO.	ITEM NO. PT. OF DWG 8861350
1 TO 9	TINNED COPPER WIRE .032 DIA.	105	75
20 TO 22	TUBING INSL. BLK. .042 I.D.	8	96
30 TO 31	WIRE, WHT BLK/RED 10/010	724-11	76
40	RED/BLK 10/010	724-11	77
70 – 76	BLACK 7/010	724-1	84
80 – 82	BROWN 7/010	724-1	85
90 – 92	BLK/BRN 7/010	724-1	86
100 – 102	BLUE 10/010	724-16	80
110 – 112	RED		81
120 – 121	ORANGE		82
130 – 131	RED/BLUE 10/010	724-16	83
140 – 141	7/010	724-1	87
150 – 151	YELLOW		88
160 – 161	YEL/BLK		89
170	YEL/RED		90
180	GREEN		91
190 – 191	GRN/RED		92
200 – 201	YEL/GRN		93
210 – 211	WIRE, WHT- GRN/BLK 7/010	724-1	94
250	SHIELDED PR. RED/BLK 7/010	472930-1	95
260 – 263	TUBING, INSL. TRANSR. 106 I.D.	722-9	97



② SAME AS PT1-EXCEPT CONNECT AT1 AS SHOWN-FOR LIST OF PARTS SEE DWG. A-8861350-502.

317298-2

Figure ALA-4. Connection Diagram



PLUG CONNECTIONS OF P1	
TERMS.	CIRCUIT
1 & 2	INPUT (MATCHING)
3	METER (−)
4	INPUT CENTER TAP
8 & 9	BRIDGING INPUT *
7	METER (+)
11 & 12	OUTPUT
13	GROUND
14 & 15	POWER LINE

* JUMPER 1-5 & 2-6

TRANSFORMER CONNECTIONS		
IMPEDANCES	INPUT T1	OUTPUT T2
150 OHMS	1-2&3-4,5 CT.	6-7,8-9
600 OHMS	2-3, 2 CT.	7-8

ALL RESISTANCES IN OHMS 1/2 WATT, AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE INDICATED.
ARROWS AT P1 INDICATE PHASING

Figure ALA-5. Schematic Diagram

Preamplifier

TYPE BA-21A

UNITS 205-H, 206-A

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31121

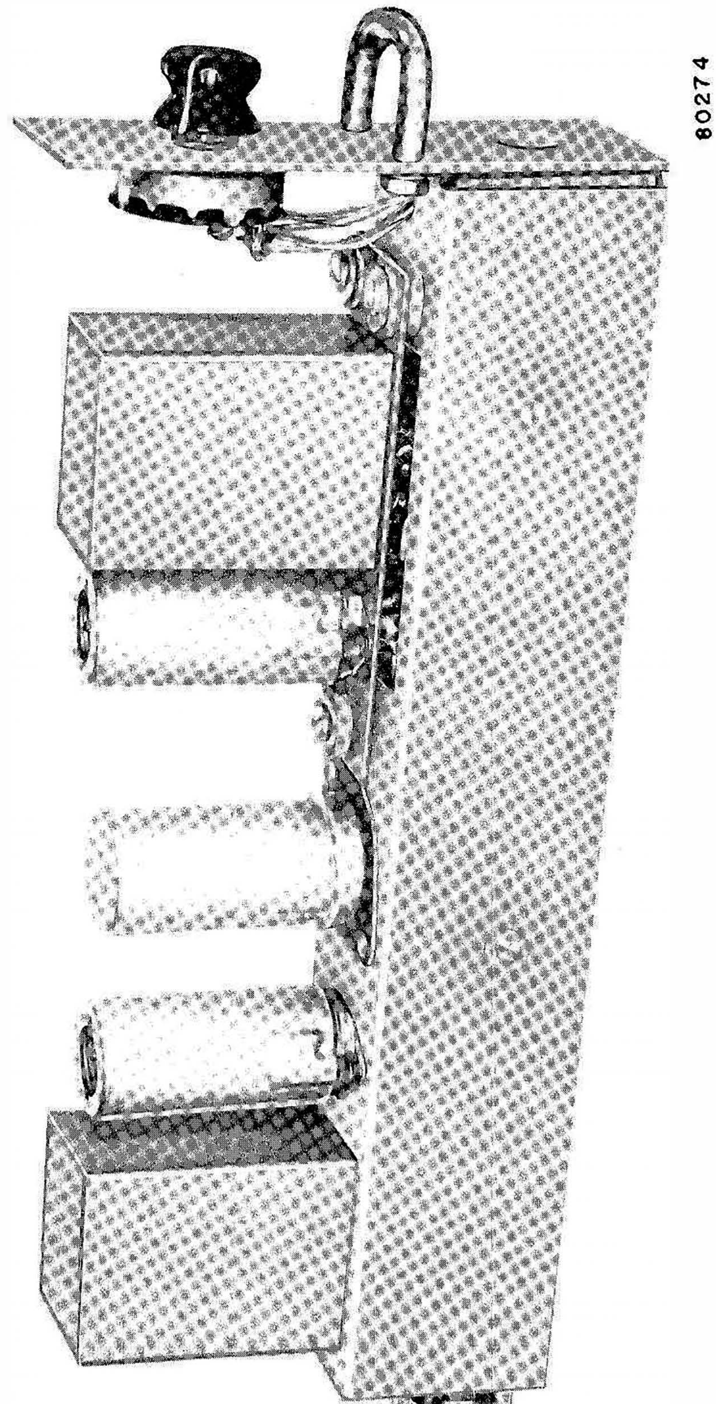


Figure APA-1—Type BA-21A Preamplifier

TECHNICAL DATA

Power Required

Plate: 285 volts dc, 10 ma
0.3 mv ripple voltage
Heater: 6.3 volts ac, 0.6 amperes

Source Impedance

150 ohm balanced source

Input Impedance

Higher than source impedance for all frequencies from 30 to 15,000 cps

Output Impedance

Approximately 100 ohms

Load Impedance

600 ohms balanced

Maximum Input Level

−22 dbm ±1 db

Rated Output Level

+18 dbm

Total RMS Harmonic Distortion (at +18 dbm output)

0.75% rms at 30 cps
0.50% rms from 50 to 15,000 cps

Insertion Gain

40 ±1 db at 1000 cps

Feedback

20 db at 1000 cps

Frequency Response

±1 db from 30 to 15,000 cps (see figure APA-2)

Hum and Noise Level

−82 dbm maximum at output

Tube Complement

1 MI-11299 (selected 12AY7)*
1 12AY7

Dimensions and Weight

Length: 10-3/8 inches (12-1/2 inches overall)
Height: 4-21/32 inches
Width: 1-5/8 inches
Weight: 2-1/2 pounds

Finish

Light umber gray

*The MI-11299 RCA selected 12AY7 is inserted in the socket nearest the front panel (XV1).

DESCRIPTION

The purpose of the BA-21A Preamplifier (figure APA-1) is to amplify the output of a low level source. Two of the units are used in the audio system, one as a microphone preamplifier (unit 205-H) and the other as a cue line amplifier (unit 206-A).

Plug-in Mounting

Each preamplifier is plug-in mounted on an MI-11597 Mounting Shelf (the microphone preamplifier on shelf 205, and the cue line amplifier on shelf 206). A guide assembly attached to the shelf facilitates insertion and withdrawal of the unit and insures correct mating of plug P1 on the rear of the chassis with jack J1 on the mounting shelf.

Terminal connections of P1 are listed in a table on the schematic diagram, figure APA-5.

Circuit

The preamplifier (see schematic diagram) consists of an input amplifier stage, V1A, a phase splitter, V1B, and a push-pull output stage V2. Input transformer T1 is tapped for source impedances of 37.5, 150, 600 ohms, but is connected for a balanced input of 150 ohms. The output of V2 is fed through output transformer T2 to pins 11 and 12 of plug P1. The split secondaries of T2 are connected in series to provide the correct turns ratio for a 600-ohm load. A tertiary winding on T2 supplies negative feedback through a resistance-capacitance network to the cathode of V1A. The feedback improves frequency response, reduces harmonic distortion, and stabilizes the amplifier gain (see figure APA-2).

Provision is made to obtain a relative indication of tube performance by monitoring the voltage across a resistor in each cathode circuit. METERING switch S1 selects the tube to be checked (see *Maintenance*).

Plate and filament voltages are supplied to the unit by the BX-21A Power Supply (unit 206C) through plug P1.

MAINTENANCE

NOTE: If trouble develops in either the cue line amplifier or microphone preamplifier necessitating immediate replacement, it should be noted that the units are identical and may be interchanged.

Routine Checks

Each preamplifier should be checked periodically to insure proper operation. This procedure should include removal of dust around components and wiring, and cleaning connector pins by moving the plug in and out of its receptacle several times.

Tube Metering

To obtain a relative indication of tube performance in either preamplifier, rotate METER SEL switch on audio junction panel (unit 204) to MIC or CUE LINE position. Rotate METERING switch on the corresponding unit to each of its three positions (V1A, V1B, V2) and note panel meter reading. The normal reading is one volt. Variations exceeding 0.15 volt indicate a departure from normal tube characteristics which may be caused by defect or aging.

Replacement of Components on Printed Circuit Board

As shown in figure APA-3, the preamplifiers contain a printed circuit board which may be detached from the chassis after removal of two screws and associated nuts and washers. If it is necessary to replace components because of failure, follow the procedure outlined in IB-31119 (BA-24A Monitoring Amplifier).

Voltage Readings

The following table indicates typical tube-socket voltages with respect to ground, measured with a 20,000 ohm-per-volt meter. Values are approximate and may vary ±10% because of normal component tolerances.

VOLTAGE CHART

Tube	*Pin*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1	200	—	55	*	*	130	0	3.1	*
V2	250	0	3.0	*	*	255	0	3.0	*

* 6.3 volts ac between pin 9 and either of pins 4 or 5.

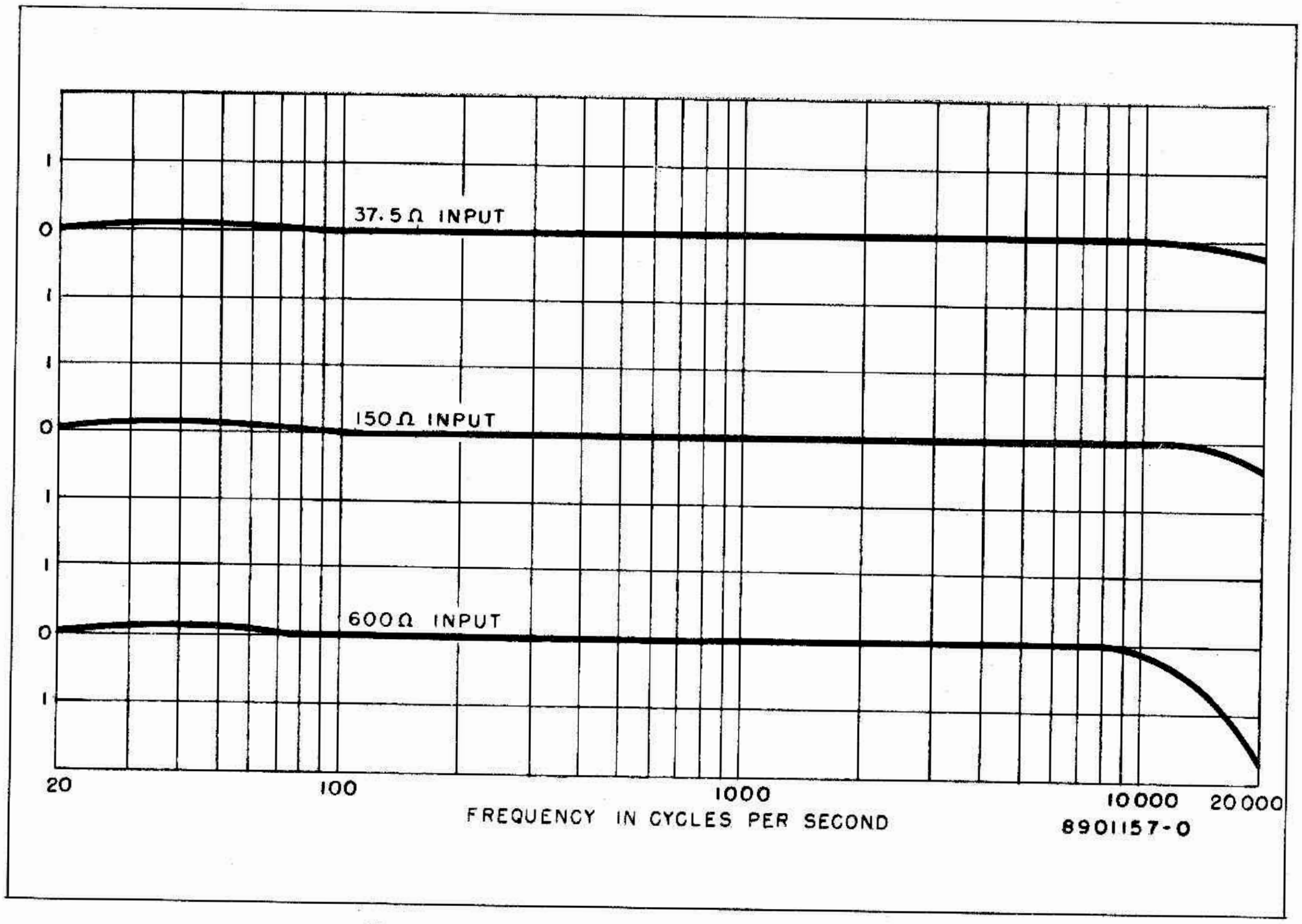


Figure APA-2—Frequency Response Curve

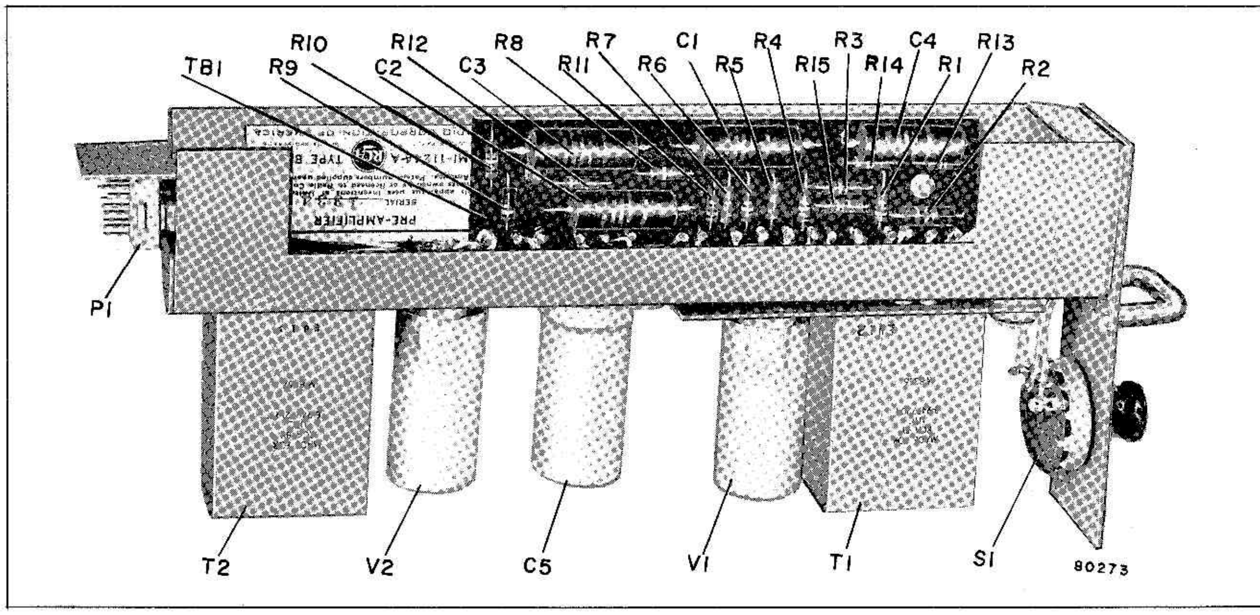
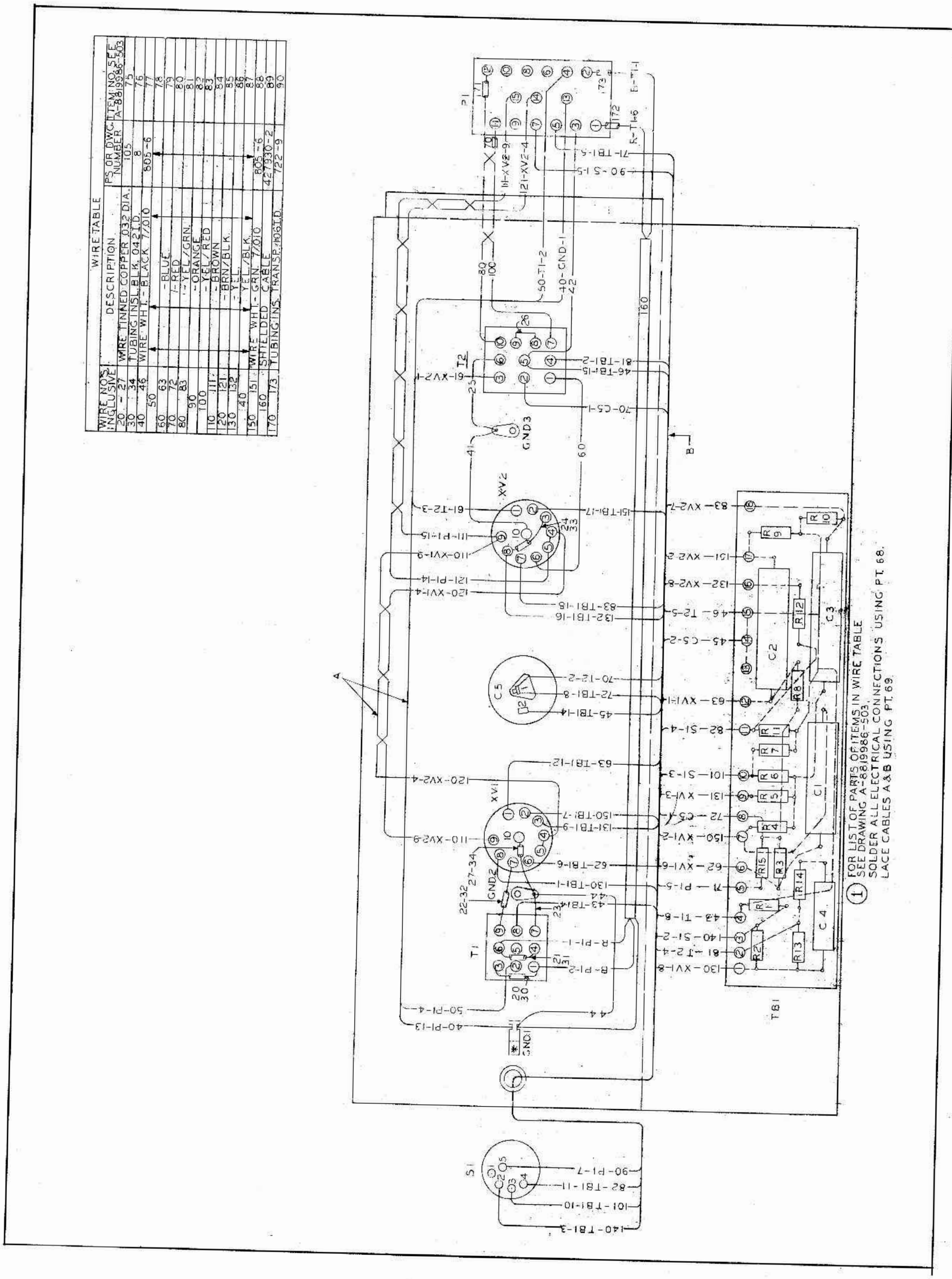


Figure APA-3—Preamplifier, Bottom View Showing Printed Circuit

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
PREAMPLIFIER, MI-11244-A			
C1 to C3		735715-171	Capacitor: fixed, paper, 0.047 µf ±10%, 400 v
C4		735715-65	Capacitor: fixed, paper, 0.015 µf ±10%, 200 v
C5	97480	95695-52	Capacitor: electrolytic, 30 µf 350 v
P1	205330	459622-1	Connector: male, 15 contact, chassis mounting
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		82283-169	2700 ohms, ±5%, ½ w
R2		90496-177	5600 ohms, ±5%, 1 w
R3		82283-215	220,000 ohms, ±5%, ½ w
R4		82283-96	680,000 ohms, ±10%, ½ w
R5		82283-181	8200 ohms, ±5%, ½ w
R6		82283-208	110,000 ohms, ±5%, ½ w
R7		82283-167	2200 ohms, ±5%, ½ w
R8		82283-208	110,000 ohms, ±5%, ½ w
R9, R10		82283-96	680,000 ohms, ±10%, ½ w
R11		82283-137	120 ohms, ±5%, ½ w
R12		82283-145	270 ohms, ±5%, ½ w
R13		82283-191	22,000 ohms, ±5%, ½ w
R14		82283-211	150,000 ohms, ±5%, ½ w
R15		82283-169	2700 ohms, ±5%, ½ w
S1	30155	8854922-2	Switch: metering
T1	205326	949720-1	Transformer: audio input
T2	205325	949721-1	Transformer: audio output
XV1, XV2	94880	737870-17	Socket: tube, 9 contact miniature
			Miscellaneous:
	205327	8872221-18	Button: plug
	206512	8861550-502	Circuit Board Assembly: etched circuit board complete, including C1-4, R1-15
	205331	459623-1	Connector: female, 15 contact, chassis mounting
	37396	65415-10	Grommet: plate mounting
	205329	741622-501	Knob: control
	28452	85558-2	Plate: mounting, for C5
	209283	8827557-5	Screw: shoulder, for P1
	56359	8858642-3	Shield: tube

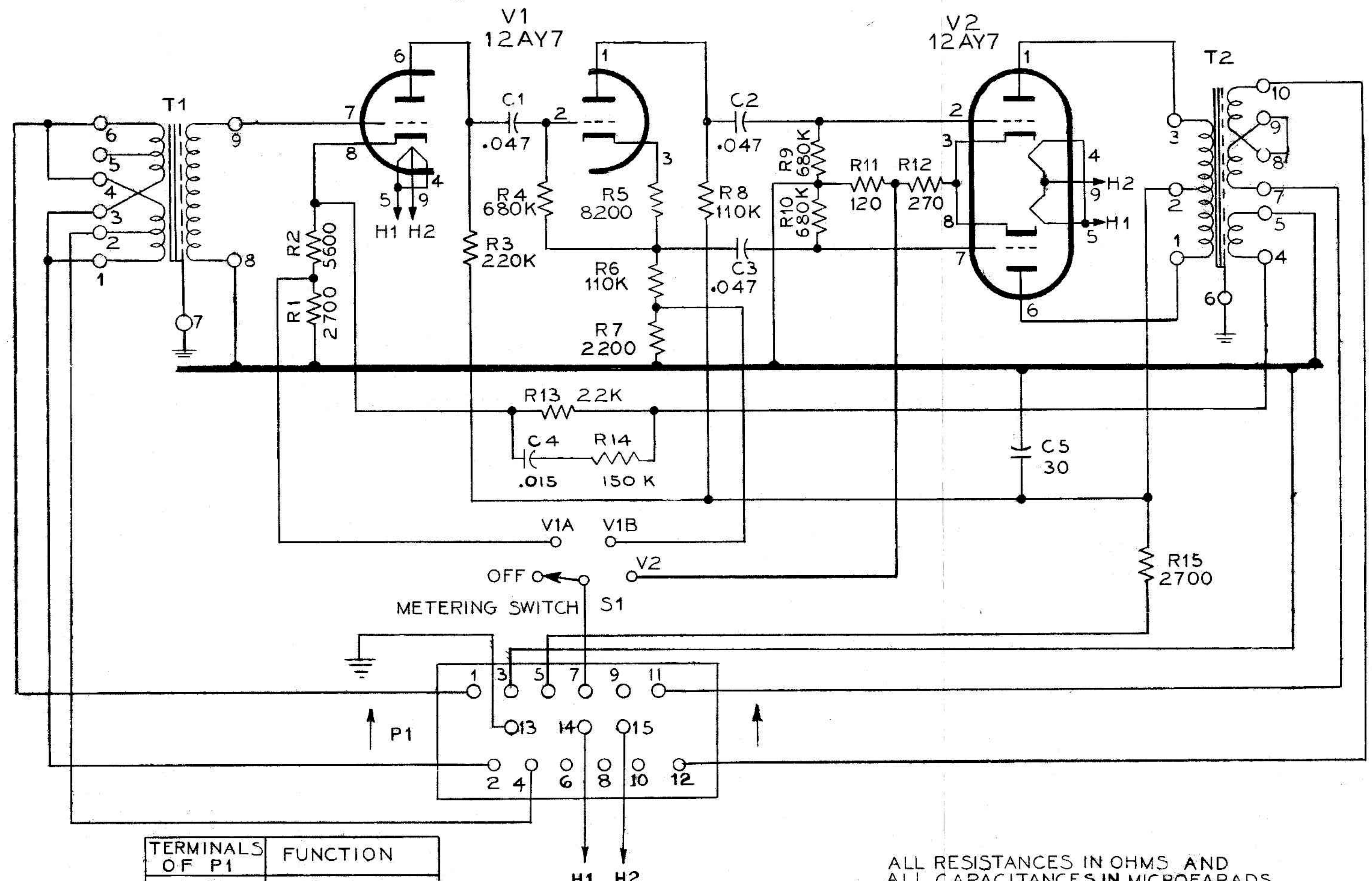


WIRE TABLE

WIRE NOS. INCLUSIVE	DESCRIPTION	PS OR DWG. NUMBER	ITEM NO. SEE A-8819986-503
20 - 27	WIRE TINNED COPPER .032 DIA.	105	75
30 34	TUBING INSL. BLK. .042 I.D.	8	76
40 46	WIRE WHT. - BLACK 7/.010	805-6	77
50			78
60 63	- BLUE		79
70 72	- RED		80
80 83	- YEL/GRN.		81
90	- ORANGE		82
100	- YEL/RED		83
110 111	- BROWN		84
120 121	- BRN/BLK.		85
130 132	- YEL.		86
140	- YEL/BLK.		87
150 151	WIRE WHT. - GRN. 7/.010	805-6	88
160	SHIELDED CABLE	427930-2	89
170 173	TUBING INS. TRANSP. .106 I.D.	722-9	90

Figure APA-4—Connection Diagram

MI-11299 RCA selected 12AY7



TERMINALS OF P1	FUNCTION
1 & 2	INPUT
3	B-
4	C.T. INPUT
5	B+
7	METERING +
11 & 12	OUTPUT
14 & 15	HEATER

TRANSFORMER CONNECTIONS		
IMPEDANCE	INPUT - T1	OUTPUT - T2
37.5 OHMS	1-5, 2-6	———
150 OHMS	1-3, 4-6, 2 C.T.	7-8, 9-10
600 OHMS	3-4, 3 C.T.	8-9

ALL RESISTANCES IN OHMS AND ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE INDICATED.

Figure APA-5—Schematic Diagram

Monitoring Amplifier

TYPE BA-24A

UNIT 206-B

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
DU 6120

IB-31119

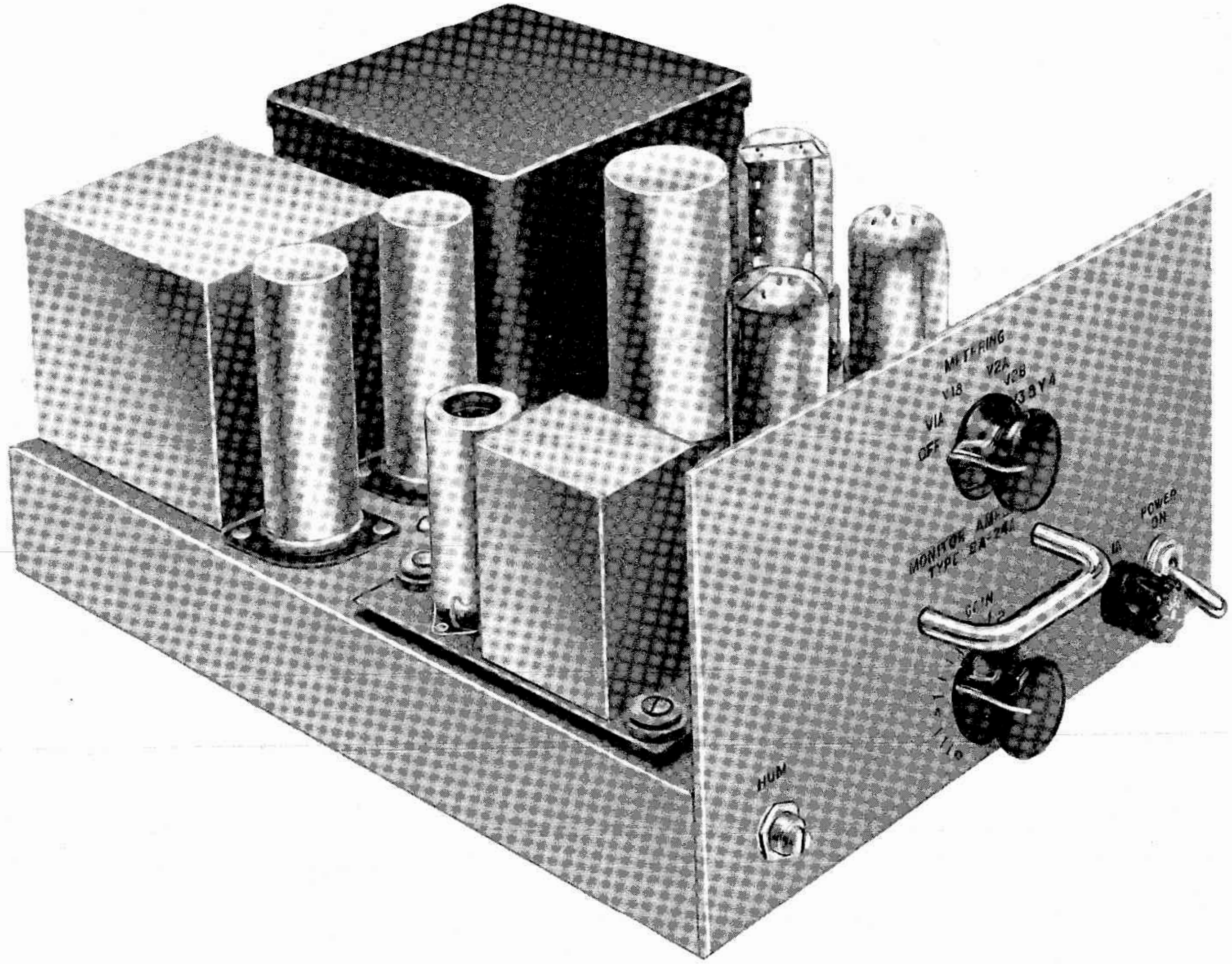


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Figure AMA-1. Monitoring Amplifier Type BA-24A

TECHNICAL DATA

Power Required
100 to 130 volts, 50/60 cycles, 70 watts.

Source Impedance
150 ohm balanced source.

Input Impedance
Approximately 20,000 ohms bridging (provided by external gain control on Control Panel).

Load Impedance
16 ohms.

Output Impedance
3 ohms (approximately).

Maximum Input Level
−30 dbm.

Maximum Output Level
10 watts (40 dbm).

Frequency Response
±2 db from 30 to 15,000 cps.

Maximum Gain
104 ±2 db.

Noise Level
−122 dbm referred to input.
−18 dbm at output with 104 db gain.

Harmonic Distortion
For 8 watts output (39 dbm):
1% from 100 to 7500 cps.
2% from 50 to 15,000 cps.

Dimensions and Weight
Length: 10⅜ inches (12½ inches overall).
Width: 8⅜ inches.
Height: 4²¹⁄₃₂ inches.
Weight: 16¼ pounds.

Fuse
1.5 amperes, time-lag.

Tube Complement

(1) MI-11299 (selected 12AY7)	Input Stage and Voltage Amplifier
(1) 12AX7	Voltage Amplifier-Phase Inverter
(2) 6V6	Output Stage
(1) 5Y3	Rectifier

DESCRIPTION

The RCA Type BA-24A Monitoring Amplifier is a high-fidelity, high-gain amplifier which drives the monitor speaker on the Control Panel of the tape recorder. The input signal to the amplifier is selected by the SPEAKER & METER SELECTOR switch on the Control Panel, and the input level is controlled by the SPEAKER VOL control, also on the Control Panel. The switch permits selecting the output of the audio system during simultaneous playback and recording, the output of the audio or cue system during playback, and the incoming audio or cue line at any time.

Controls

Figure AMA-1 shows the controls on the amplifier front panel. These consist of a POWER ON-OFF switch, HUM adjustment, GAIN control, and a METERING switch (to permit selective metering of tube currents).

Plug-In Mounting

The amplifier is plug-in mounted on an MI-11597 Mounting Shelf. A guide assembly attached to the shelf facilitates insertion and withdrawal of the unit and insures correct mating of plugs P1 and P2 on the rear of the chassis with their receptacles J1 and J2 on the shelf.

Terminal connections of P1 and P2 are listed in a table on schematic diagram 317289, figure AMA-7.

Circuit

The unit consists of a five-stage amplifier and a self contained power supply. (Refer to schematic diagram, figure AMA-7).

Input transformer T1 is tapped for source impedances of 37.5, 150, 600 ohms, but is connected for a 150-ohm balanced source. The source is coupled by transformer T1 to the first stage of voltage amplification (V1A) which is resistance-capacitance coupled to the second stage, V1B. GAIN control R4, in the grid circuit of V1B, determines the output level of the monitoring amplifier.

After further amplification by V2A the signal is fed to phase splitter V2B, which supplies two equal voltages of opposite phase to push-pull output stage V3-V4. A tertiary winding on the output transformer, T2, supplies negative feedback to the cathode of V2A to improve frequency response, reduce harmonic distortion, and stabilize the amplifier gain (figure AMA-2). The secondary winding of T2 is tapped for load impedances of 4, 8, 16, 150, or 600 ohms. The

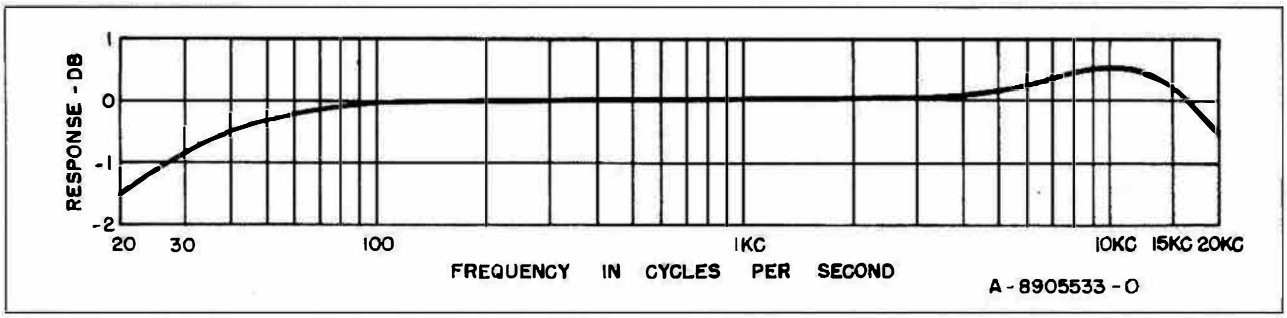


Figure AMA-2. Frequency Response Curve

taps are connected to plug P2 as shown in the schematic diagram. As used in the tape recorder, terminals 6 and 10 of plug P2 (16-ohm output) are connected through receptacle J2 to the monitor speaker on the Control Panel.

Provision has been made to monitor tube currents by measuring the voltage drop across a cathode resistor in each amplifier stage. METERING switch S2 selects the tube to be monitored (see *Maintenance*).

The self contained power supply consists of a power transformer (T3) a full-wave rectifier (V5), and a resistance-capacitance filter.

ADJUSTMENTS

GAIN Adjustment

To adjust volume initially, observe the following procedure while playing back a tape with SPEAKER and METER SELECTOR switch on Control Panel in AUDIO REC/PLAY position:

1. Rotate SPEAKER VOL control, on Control Panel, fully clockwise.

2. Adjust GAIN control on monitoring amplifier until volume is greater than normally required.

3. Lower volume to desired level with SPEAKER VOL control.

HUM Adjustment

Adjust HUM control (R25) for minimum hum in the monitoring amplifier output signal.

Power Transformer Connections

Power transformer T3 is designed for operation at 105, 115, and 125 volts, 50/60 cycles, but is originally connected for a 115-volt line. If the line voltage is above 120 volts, disconnect the black and red tracer wire from the 115-volt tap (terminal 3 of T3) and connect it to the 125-volt tap (terminal 4 of T3). If the voltage is below 110 volts, connect the black and red tracer wire to the 105-volt tap (terminal 2 of T3).

MAINTENANCE

Routine Checks

To insure proper operation, the amplifier should be checked periodically. The procedure should include removal of dust around components and wiring, and cleaning the connector pins by moving the plugs in and out of their receptacles several times.

Tube Metering

The six position METERING switch S2 permits checking each tube by obtaining a relative indication of the cathode current. Provision for reading tube currents is provided by a meter on the Audio Junction panel. Rotate the meter selector switch on the panel to MON., then select the tube to be monitored by rotating the METERING switch on the Monitor Amplifier. A variation greater than 0.15 volt dc indicates a departure from normal tube characteristics, which may be caused by defect or aging.

Fuse Replacement

When fuse replacement is required use one with the same type and rating (1.5 amp, 125 v time-lag) as the original. Do not use a fuse of higher rating as this will needlessly endanger the windings of the power transformer.

Replacement of Components on Printed Circuit Board

As shown in figure AMA-5, the monitoring amplifier contains a removable printed circuit board. Components which form an integral part of the printed circuit board are indicated in figure AMA-3.

To Isolate a Component: If it becomes necessary to isolate a component while troubleshooting, the following procedure should be observed:

1. Loosen one of the component leads by melting the solder surrounding the lead with a small 25-watt soldering iron.

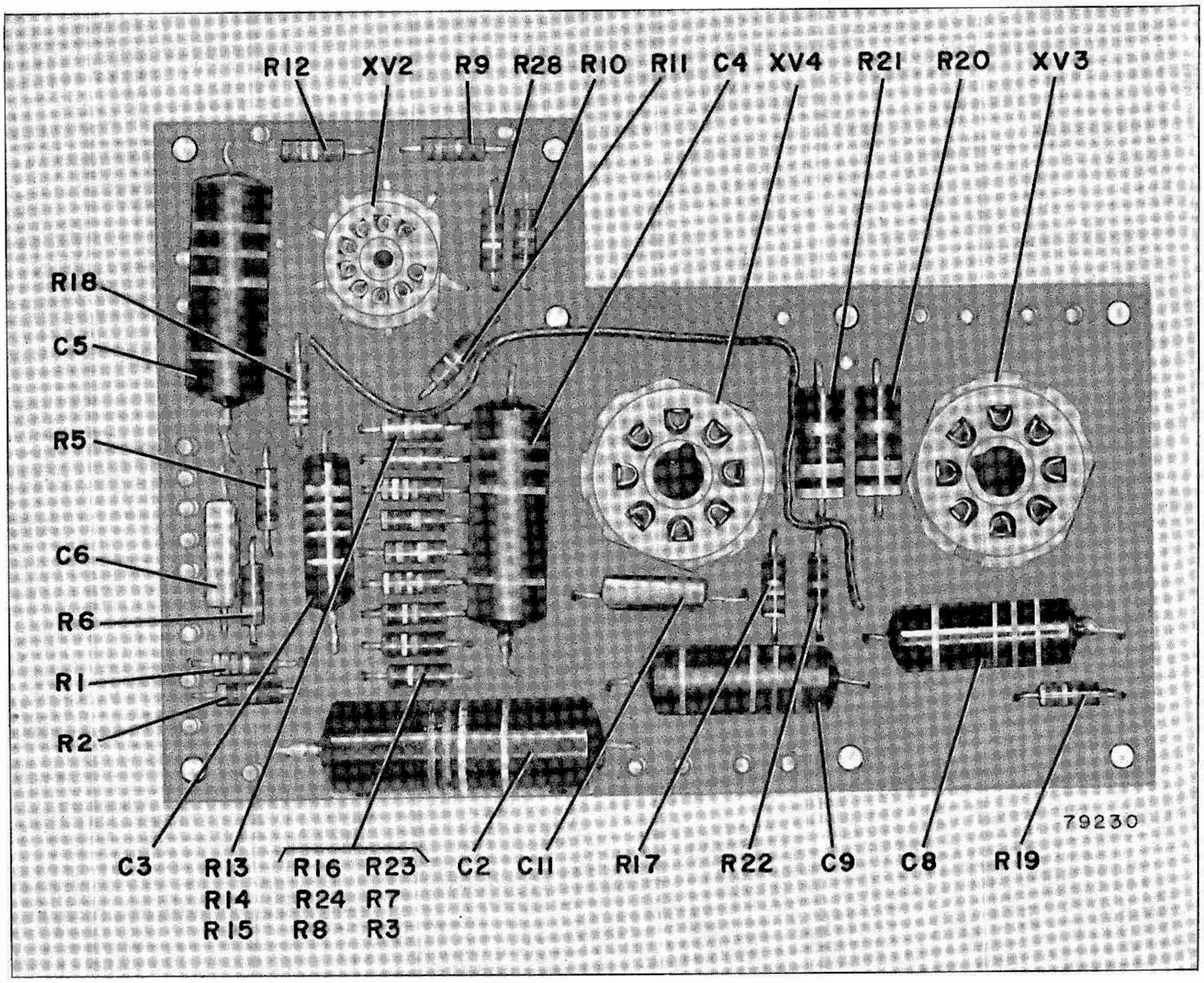


Figure AMA-3. Printed Circuit Board Components

2. With long nosed pliers, straighten the bent portion of the lead before pulling it through the hole from the component side.

3. To replace the component lead, reverse the procedure. Be careful not to damage the copper foil by excessive force or heat.

To Replace a Component: Most of the components are accessible through openings in the chassis. Greater accessibility can be obtained by tilting the board after removing the eight screws and associated washers. To replace defective components, proceed as follows:

1. Isolate defective component.

2. To remove the component, snip the leads off at the component side of the board. (Refer to figure AMA-4.)

3. Using a small soldering iron (25 w), heat the leads and remove them from the printed wiring side of the board. Avoid damaging the thin printed conductors by applying excessive force or heat.

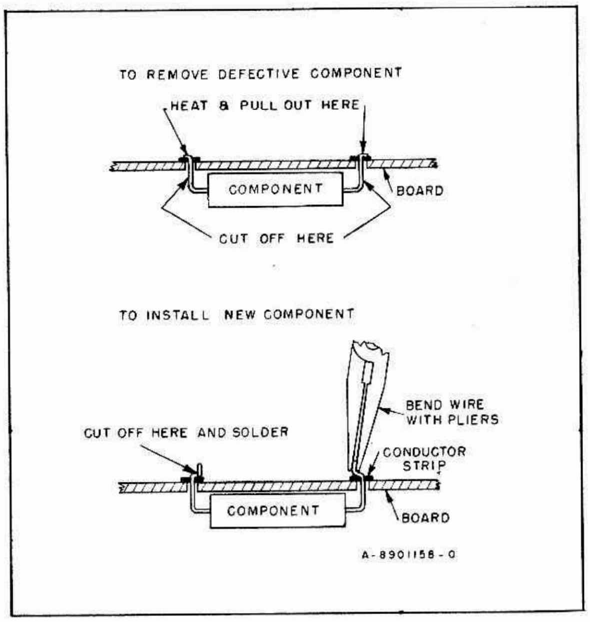


Figure AMA-4. Method of Replacing Component on Printed Wiring Board

4. Clean and preform the leads of the new component and insert them through the holes until the component body is tight against the board.

5. On the printed circuit side, grasp the component lead and bend it over in the direction of the circuit pattern.

6. Crimp the wire tightly against the board and cut off the excess component lead. Allow approximately 1/16-inch of lead to protrude from the edge of the hole.

7. Heat the lead and apply rosin core solder. *Do not use paste or acid flux.* Remove excess flux from the joints with alcohol.

8. Replace the circuit board on the amplifier chassis.

Voltage Readings

The following table indicates typical tube-socket voltages with respect to ground, measured with a 20,000 ohm-per-volt meter.

VOLTAGE CHART

Tube	*Pin Number**								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1	90 +10	0	1.7 ±.2	21 ±3	21 ±3	117 ±12	0	2.0 ±.2	21 ±3
V2	165 ±15	0	1.7 ±.2	21 ±3	21 ±3	257 ±26	—	45 ±5	21 ±3
V3	NC	21 ±3	310 ±20	320 ±20	0	NC	21 ±3	21 ±3	NC
V4	NC	21 ±3	310 ±20	320 ±20	0	NC	21 ±3	21 ±3	NC
V5	NC	380 +20	NC	370 +15 ac	NC	370 +15 ac	NC	380 +20	NC

* All voltages dc unless otherwise noted.

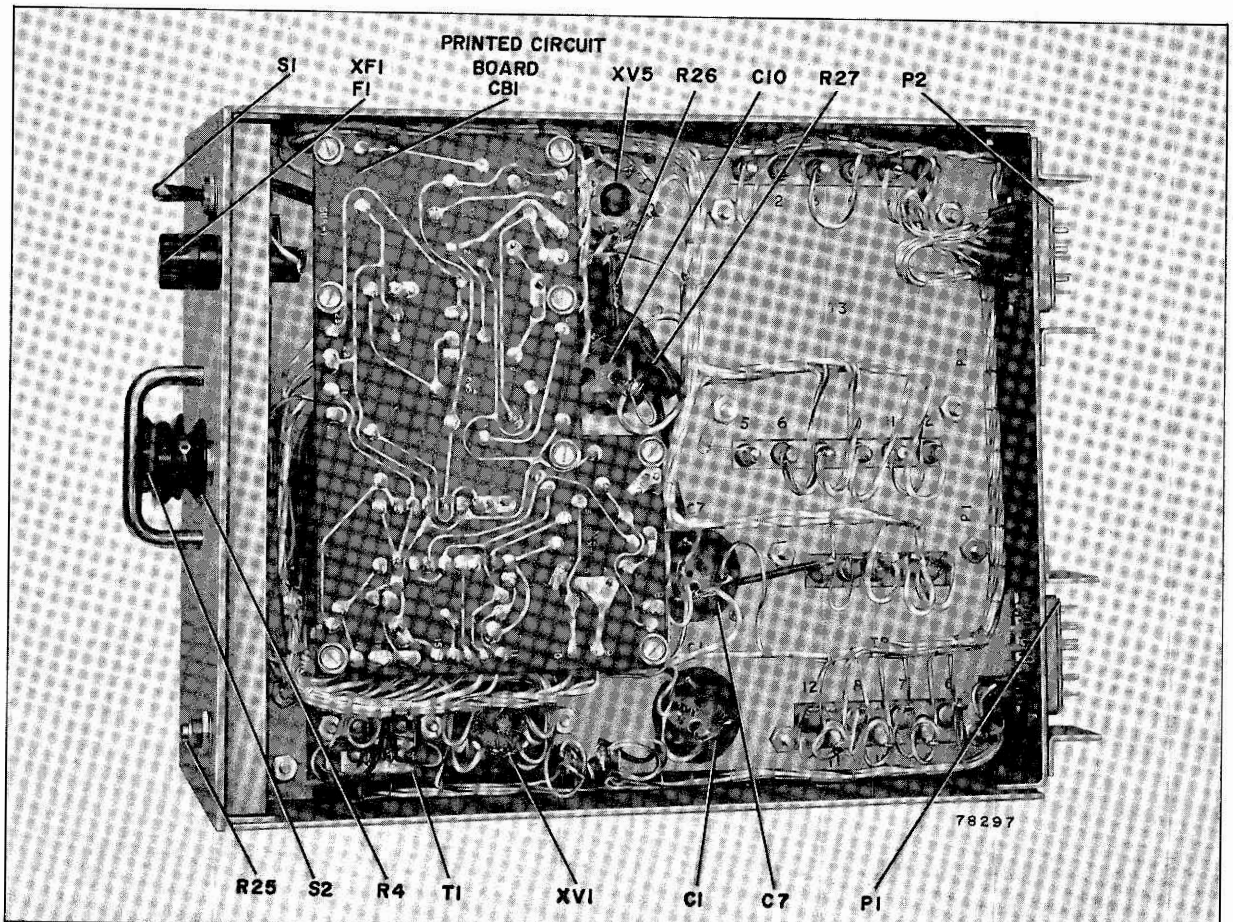


Figure AMA-5. Bottom View of BA-24A Amplifier

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
			MONITORING AMPLIFIER, MI-11247
			CAPACITORS:
C1A, B	94146	95695-20	electrolytic, 40-20 μf -10 +250%/-10 +50%, 25/450 v
C2		735715-179	paper, 0.22 μf ±10%, 400 v
C3		735715-161	paper, 6800 μμf ±10%, 400 v
C4, C5		735715-175	paper, 0.1 μf ±10%, 400 v
C6		727856-121	mica, 82 μμf ±10%, 500 v
C7A, B	94146	95695-20	electrolytic, 40-20 μf -10 +250%/-10 +50%, 25/450 v
C8, C9		735715-171	paper, 0.047 μf ±10%, 400 v
C10A, B	102913	442900-29	electrolytic, 40/40 μf -10 +50%, 450 v
C11		727856-119	mica, 68 μμf ±10%, 500 v
C12		727876-131	mica, 220 μμf ±10%, 1000 v
F1	98682	990157-109	Fuse: 1.5 amp 125 v
P1, P2	205330	459622-1	Connector: male, 15 contacts chassis mtg.
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1		735730-151	470 ohms, ±5%, ½ w
R2		735730-156	750 ohms, ±5%, ½ w
R3		735730-207	100,000 ohms, ±5%, ½ w
R4	218035	746053-24	variable, comp., 250,000 ohms, ±10%, 2 w
R5		735730-159	1000 ohms, ±5%, ½ w
R6		735730-162	1300 ohms, ±5%, ½ w
R7		735730-215	220,000 ohms, ±5%, ½ w
R8		735730-94	470,000 ohms, ±10%, ½ w
R9		735730-162	1300 ohms, ±5%, ½ w
R10		735730-166	2000 ohms, ±5%, ½ w
R11		735730-215	220,000 ohms, ±5%, ½ w
R12		735730-191	22,000 ohms, ±5%, ½ w
R13		735730-94	470,000 ohms, ±10%, ½ w
R14		735730-64	1500 ohms, ±10%, ½ w
R15		735730-197	39,000 ohms, ±5%, ½ w
R16		735730-157	820 ohms, ±5%, ½ w
R17		735730-94	470,000 ohms, ±10%, ½ w
R18		735730-197	39,000 ohms, ±5%, ½ w
R19		735730-94	470,000 ohms, ±10%, ½ w
R20, R21		99126-150	430 ohms, ±5%, 2 w
R22		735730-113	12 ohms, ±5%, ½ w
R23		735730-74	10,000 ohms, ±10%, ½ w
R24		735730-72	6800 ohms, ±10%, ½ w
R25	206037	737801-24	variable, comp., 500 ohms, ±20%, ¼ w
R26	208032	458592-10	wire wound, 150 ohms, ±10%, 5 w
R27	208033	458592-13	wire wound, 500 ohms, ±10%, 5 w
R28		735730-84	68,000 ohms, ±10%, ½ w
S1	48791	187454-2	Switch: toggle S.P.S.T.
S2	56583	8838619-4	Switch: rotary single circuit, 6 position
T1	205326	949720-1	Transformer: input
T2	207434	949799-1	Transformer: audio output
T3	207435	949726-1	Transformer: power
XF1	205914	8811104-1	Holder: fuse
XV1	94880	737870-17	Socket: tube, 9 contact, with shield
XV2	207706	8817696-1	Socket: tube, 9 contact
XV3, XV4	207707	8817694-1	Socket: tube, 8 contact
XV5	50367	87156-1	Socket: tube, 8 contact
			Miscellaneous:
	205331	459623-1	Connector: female, 15 contacts, chassis mtg.
	37396	65415-10	Grommet: plate mtg.
	30075	712336-507	Knob: control
	207436	8904445-501	Printed circuit: complete with all components assembled
	14974	8888539-142	Screw: set #8-32 x 3/16 lg.
	209283	8827557-5	Screw: shoulder, for P1
	56359	8858642-3	Shield: tube.

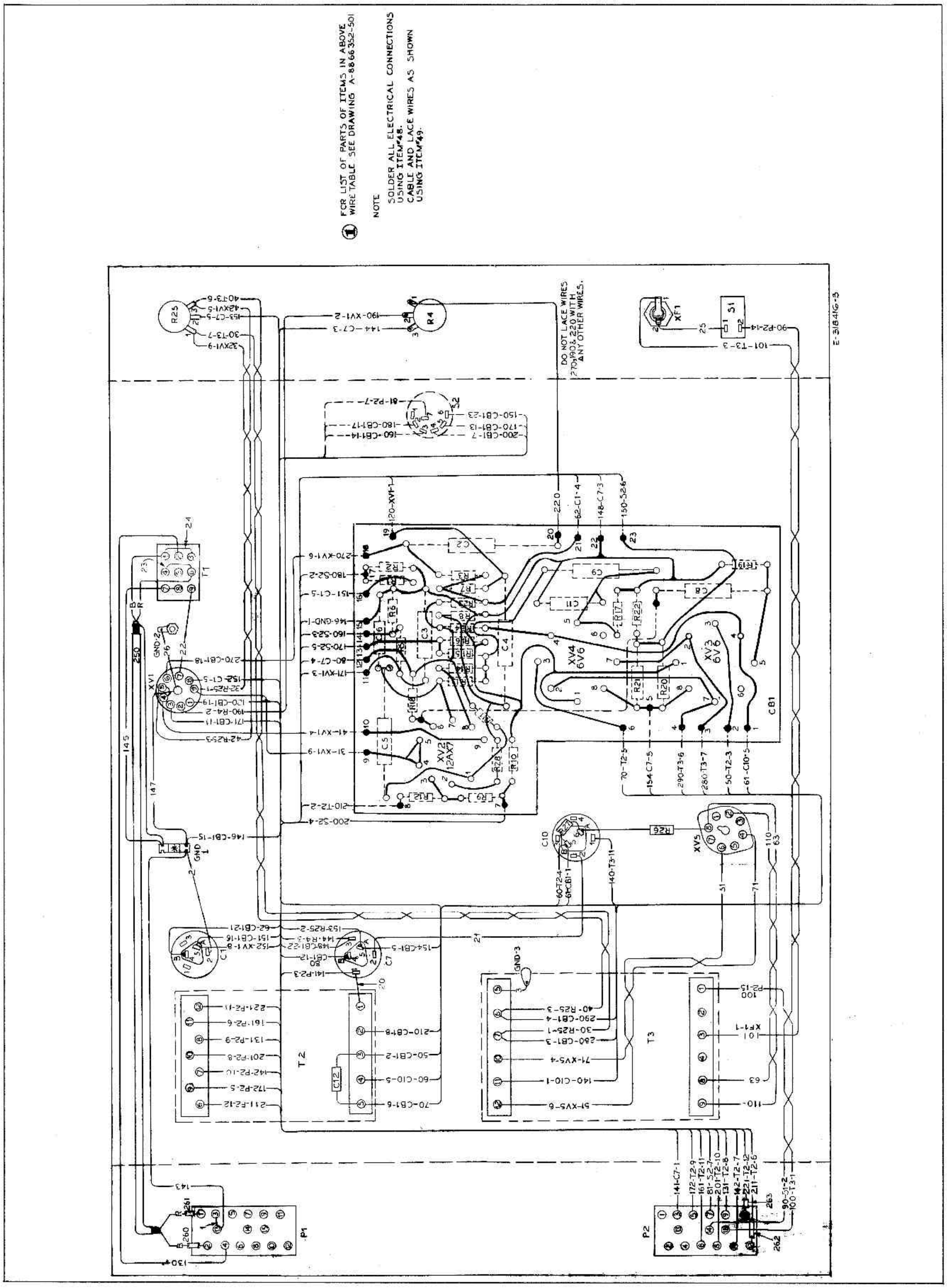
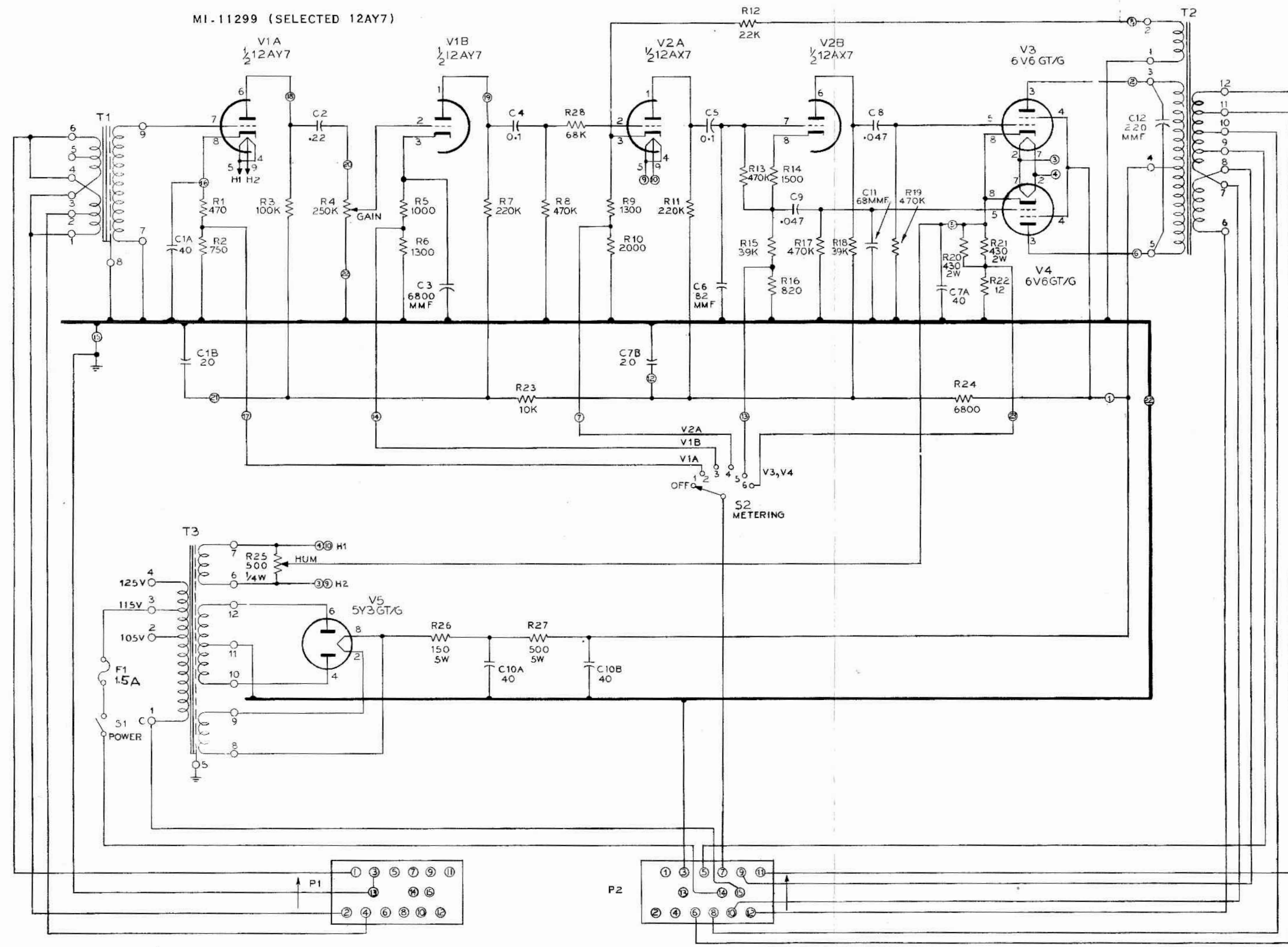


Figure AMA-6. Connection Diagram



CONNECTIONS – T1 *		
600 Ω	JUMPER 3-4	C.T. 3
150 Ω	JUMPER 1-3, 4-6	C.T.-2
37.5 Ω	JUMPER 1-5, 2-6	

CONNECTIONS—P1	
INPUT *	1-2
CENTER TAP	4
GROUND	3-13

CONNECTIONS — P2		JUMPER
600 Ω OUTPUT	11-12	9-10
150 Ω OUTPUT	11-12	9-11, 10-12
16 Ω OUTPUT	6-10	9-10
8 Ω OUTPUT	8-10	9-10
4 Ω OUTPUT	5-10	9-10
METERING	3-, 7+	
A C LINE	14-15	

ALL RESISTOR VALUES IN OHMS ½ WATT,
ALL CAPACITOR VALUES IN MICROFARADS
UNLESS OTHERWISE SPECIFIED.
ENCIRCLED NO'S 1 TO 23 CORRESPOND TO TERMINAL NO'S OF PRINTED CIRCUIT BOARD.
ARROWS AT P1 & P2 INDICATE PHASING.

E-317289-3

Figure AMA-7. Schematic Diagram

ELECTRONIC RECORDING PRODUCTS

Preamplifier Power Supply

TYPE BX-21A

UNIT 206-C

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31120

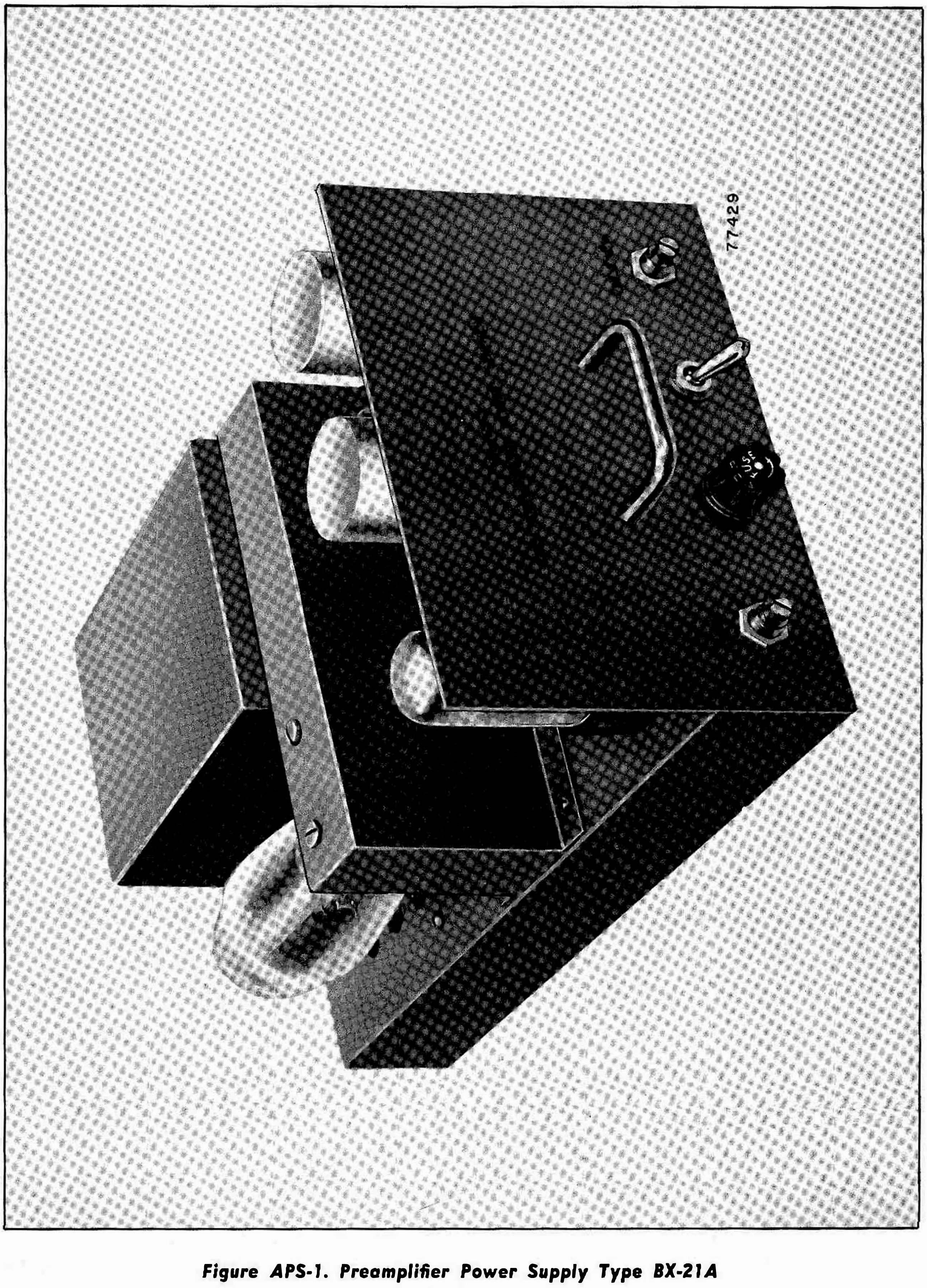


Figure APS-1. Preamplifier Power Supply Type BX-21A

TECHNICAL DATA

Power Required

100 to 130 volts, 50/60 cps
130 watts
95% power factor

Plate Power Supplied

Output voltage:	285 volts dc (adjustable from 245v to 295v).
Output current:	10 to 100 ma dc
Ripple voltage:	0.3 mv maximum
Regulation:	a. Full load to no load: 0.2% b. With ±5% line voltage variation: 0.1%

Heater Power Supplied

6.3 volts ac, 6.0 amps (maximum).

Fuse (in primary circuit)

2 ampere, time-lag

Tube Complement

1 5R4-GY
1 6BX7-GT
1 12AX7
1 OA2

Dimensions and Weight

Length: 10⅜ inches (12½ inches overall).
Height: 4²¹⁄₃₂ inches
Width: 6¹¹⁄₁₆ inches
Weight: 16 pounds

Finish

Light umber gray.

DESCRIPTION

The RCA Type BX-21A Preamplifier Power Supply (see figure APS-1) supplies plate and heater power to the following chassis of the tape recorder:

1. Cue Line Amplifier (RCA Type BA-21A Preamplifier).
2. Microphone Preamplifier (RCA Type BA-21A).
3. Audio and Cue Record Preamplifiers.
4. Audio and Cue Erase Oscillators.
5. Audio and Cue Playback Preamplifiers (plate voltage to both tubes; filament voltage to second tube only).

Controls

As shown in figure APS-1, controls on the front panel of the power supply consist of a toggle switch (POWER ON-OFF), and two screwdriver adjustments (HUM and VOLTAGE).

Metering

With METER SEL switch on audio junction panel (unit 204) placed in P.S. position, the panel meter will read one volt when the power supply output is 285 volts dc.

Plug-In Mounting

The power supply is guided into position on the mounting shelf (unit 206) by a guide plate attached to the shelf. A 15 pin male plug (P1), extending from the rear of the chassis, engages a female receptacle (J1) attached to the rear of the guide plate.

All external wiring to the unit is connected to the terminals of J1 as shown on the table below the schematic diagram, figure APS-4.

Circuit

As shown on the schematic diagram, figure APS-4, the power supply circuit comprises a full-wave high-vacuum rectifier (V1), a resistance-capacitance filter (R1, C1, C2), and a series regulator circuit. The regulator circuit consists of a regulator tube (V2) in series with the load, a dc amplifier (V3), and a gaseous type voltage regulator tube (V4).

Regulation is accomplished by feeding a portion of the output voltage through amplifier V3 to the grids of series regulator tube V2. Any variation in the output voltage produces a change in the grid bias of V2 which effectively varies the resistance in series with the load and restores the output voltage to its original value. Gaseous regulator tube V4 provides a fixed positive reference voltage of 150 volts, which is used to stabilize the operating points of both sections of amplifier V3. The operating points are determined by the setting of VOLTAGE control R10, which applies a portion of the reference voltage to the grid of the first section of V3.

VOLTAGE control R10 allows adjustment of the output voltage from 245 to 295 volts dc. As used in the tape recorder, this control is adjusted for an output of 285 volts. An external metering circuit applies a portion of the output voltage, obtained from voltage divider R18-R19, to pin 6 of P1. When the output is correctly adjusted to 285 volts dc, one volt will appear between pins 6 and 3 of P1.

To prevent hum due to heater-cathode emission in V3, part of the positive reference voltage is applied to the heaters of V3 through the HUM control R12.

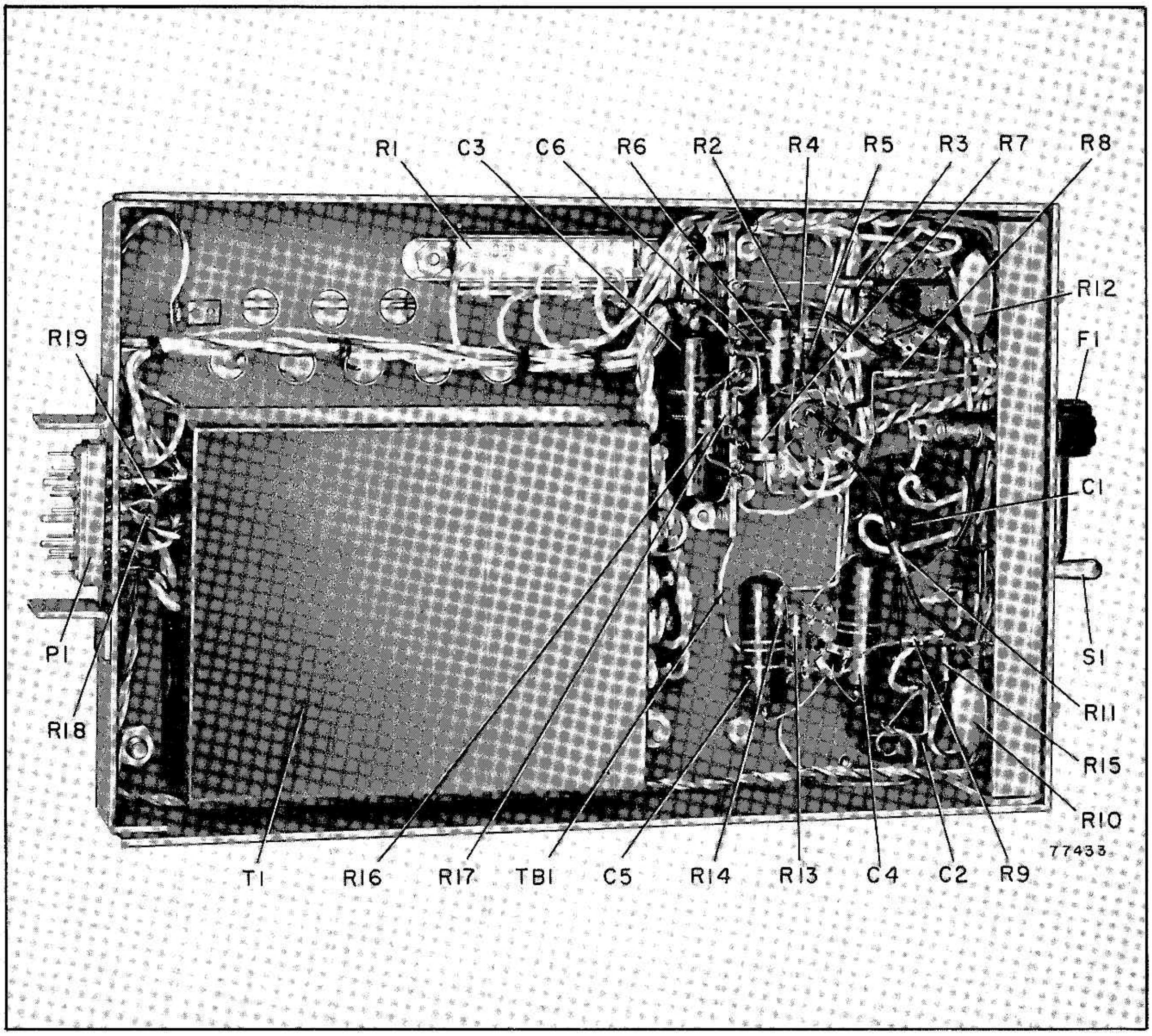


Figure APS-2. Bottom View of Power Supply

ADJUSTMENTS

Power Transformer Connections

Power transformer T1 is designed for operation at 105, 115, and 125 volts, 50/60 cycles, and is normally connected for a 115-volt line. The primary lead may be moved to the 105 or 125 volt tap after first removing the cover (shown in figure APS-2) which is secured by five screws.

If the ac line voltage is below 110 volts, transfer the primary lead on T1 from the 115-volt terminal (3) to the 105-volt terminal (2). If the ac line voltage is above 120 volts, transfer the primary lead from the 115-volt terminal (3) to the 125-volt terminal (4).

VOLTAGE Adjustment

Adjust the plate supply voltage for 285 volts dc, using the VOLTAGE screwdriver adjustment, with the system in SETUP mode of operation. An accurate external dc voltmeter must be used to make this adjustment. A convenient place to measure the voltage is between terminals 5 and 6 of terminal board TB1 (terminal 6 is ground), on audio shelf-2 (unit 206).

HUM Adjustment

Adjust HUM screwdriver adjustment for minimum hum as measured with an a-c vacuum-tube volt meter placed across the AUD LINE OUT connector on the rear of the control panel (unit 305). Terminate the audio line output with 600 ohms when making this adjustment.

MAINTENANCE

Routine Checks

A periodic inspection of the power supply should be made which includes frequent checks on tube performance using a tube tester. Components and wiring should also be inspected periodically, and any dust which may have collected should be removed. The plug connectors should be cleaned by moving the supply in and out of its receptacle several times.

Voltage Readings

The table of *Socket Voltages* shows typical voltage-to-ground readings at the tube socket terminals (dc unless otherwise noted). These readings have been obtained with a 20,000 ohm-per-volt meter and may vary ±10% because of normal component tolerances.

Fuse Replacement

When replacing a fuse, make sure that the replacement is of the correct type and rating (2 ampere, time-lag). Do not use a fuse of higher rating for replacement purposes, since this will needlessly endanger the power transformer windings.

Trouble Shooting

In the event of power supply malfunction, check tubes and fuse. If trouble cannot be corrected by this procedure, refer to *Trouble Shooting Chart.*

SOCKET VOLTAGES

Tube	*Pin Numbers*								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1 (5R4-GY)	NC	390	NC	365 ac	NC	365 ac	NC	390	NC
V2 (6BX7-GT)	285	375	285	285	375	285	285	285	NC
V3 (12AX7)	148	70	72	32	32	285	148	150	32
V4 (OA2)	150	0	NC	0	150	NC	0	NC	NC

TROUBLE SHOOTING CHART

Symptom	*Cause and Remedy*
No output voltages.	Power switch turned off, or fuse blown. Check for shorts in external and internal wiring before replacing fuse.
No d-c supply voltage.	5R4-GY rectifier tube (V1) defective. 6BX7-GT regulator tube (V2) defective. Resistor R1 A, B, or C open.
DC supply voltage high or low, but adjustable by VOLTAGE control.	VOLTAGE control R10 incorrectly adjusted. If d-c voltage can be adjusted to 285 volts with the power supply unloaded but cannot be properly adjusted with full load applied, the 5R4-GY and/or 6BX7-GT tubes have low emission and should be replaced.
DC supply voltage low, but not adjustable by VOLTAGE control.	One half of 12AX7 amplifier tube (V3) defective. Resistors R9, R10, or R11 open.
DC supply voltage low, but not adjustable by VOLTAGE control.	Capacitor C3 shorted. OA2 voltage reference tube (V4) not operating properly.
DC voltage high, but not adjustable by VOLTAGE control.	OA2 voltage reference tube removed or defective. One half of 12AX7 amplifier tube defective, or tube removed from circuit. Resistors R7, R10, or R15 open.
OA2 voltage reference tube (V4) does not glow.	OA2 tube defective. Resistors R5 and/or R6 open. Capacitor C5 shorted.
Oscillations in d-c output voltage.	Capacitor C6 or resistor R17 open.
Excessive hum component in d-c output voltage.	Capacitor C3 open. Electrolytic capacitors C1 and/or C2 low in capacity.
Excessive high frequency noise component in d-c output voltage.	Capacitor C5 open.

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
			PREAMPLIFIER POWER SUPPLY, MI-11317
C1A, B C2A, B	213897	8817680-4	Capacitor: electrolytic, 40-40 μf 500 v
C3		735715-129	Capacitor: fixed, paper, 0.22 μf ±20%, 400 v
C4, C5		735715-175	Capacitor: fixed, paper, 0.1 μf ±10%, 400 v
C6		735715-257	Capacitor: fixed, paper, 0.0033 μf ±10%, 400 v
F1	93939	990157-110	Fuse: slo-blo 2 amp
P1	205330	459622-1	Connector: plug, 15 contacts
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
R1A/C	206036	459685-1	wire wound, 3 sections 50-50-50 ohms, ±10%, 6 w
R2, R3		735730-50	100 ohms, ±10%, ½ w
R4		735730-94	470,000 ohms, ±10%, ½ w
R5, R6		99126-79	27,000 ohms, ±10%, 2 w
R7		99126-199	47,000 ohms, ±5%, 2 w
R8		735730-94	470,000 ohms, ±10%, ½ w
R9		735730-86	100,000 ohms, ±10%, ½ w
R10	206038	746053-23	variable, carbon 50,000 ohms, ±10%, ¼ w
R11		735730-86	100,000 ohms, ±10%, ½ w
R12	206037	737801-24	variable, carbon, 500 ohms, ±20%, ¼ w
R13		735730-85	82,000 ohms, ±10%, ½ w
R14		735730-78	22,000 ohms, ±10%, ½ w
R15		735730-86	100,000 ohms, ±10%, ½ w
R16		90496-188	16,000 ohms, ±5%, 1 w
R17		735730-69	3900 ohms, ±10%, ½ w
R18	96548	8898692-225	precision, carbon 560,000 ohms, ±1%, ½ w
R19	206039	8898692-166	precision, carbon 2000 ohms, ±1%, ½ w
S1	48791	187454-2	Switch: toggle
T1	206061	949765-1	Transformer: power
XF1	205914	8811104-1	Holder: fuse
XV1, XV2	68590	99391-2	Socket: tube, octal
XV3	94926	737870-9	Socket: tube, 9 pin
XV4	94925	737867-9	Socket: tube, 7 pin
			Miscellaneous:
	205331	459623-1	Connector: female, 15 contacts
	56560	57421-3	Grommet: panel mounting

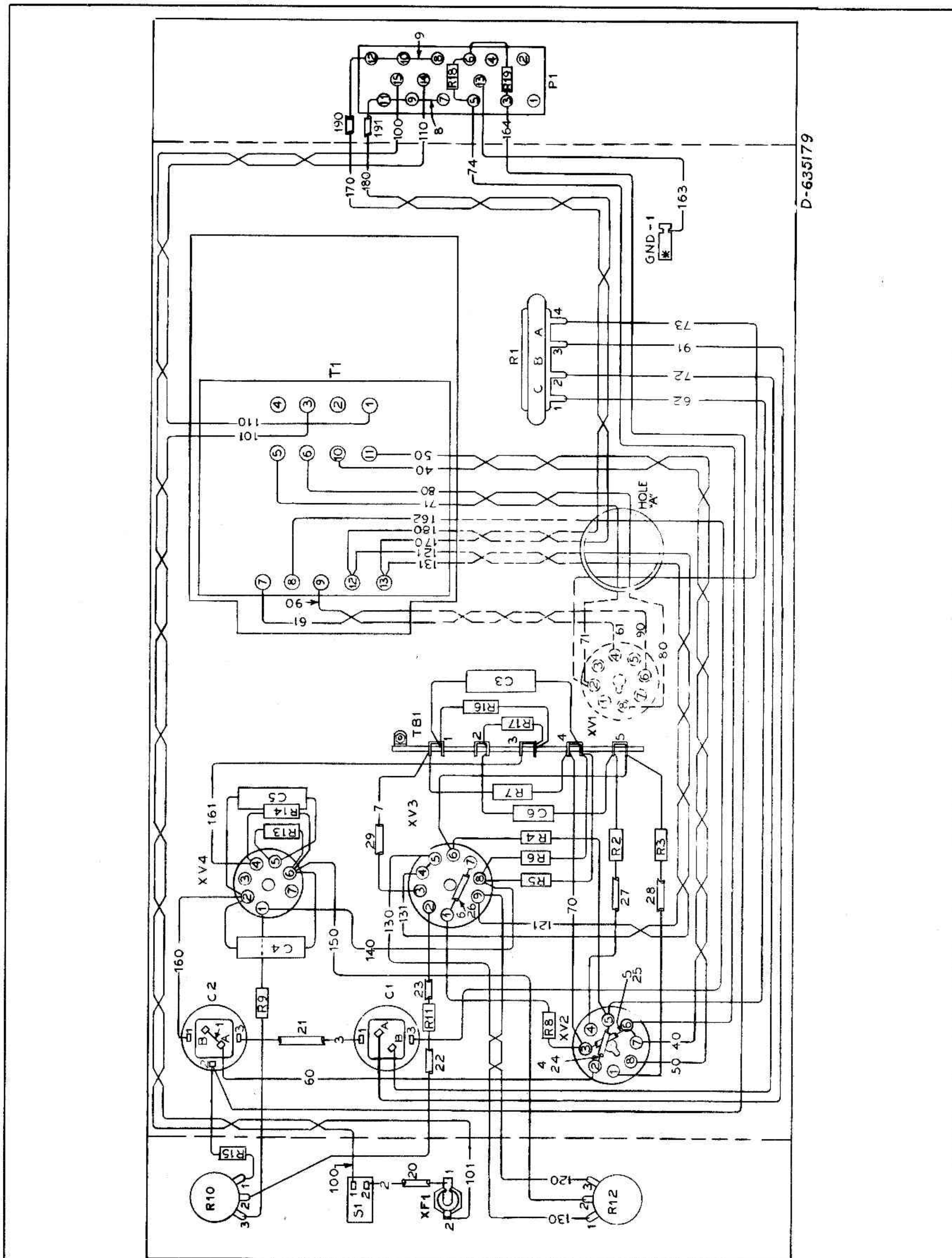
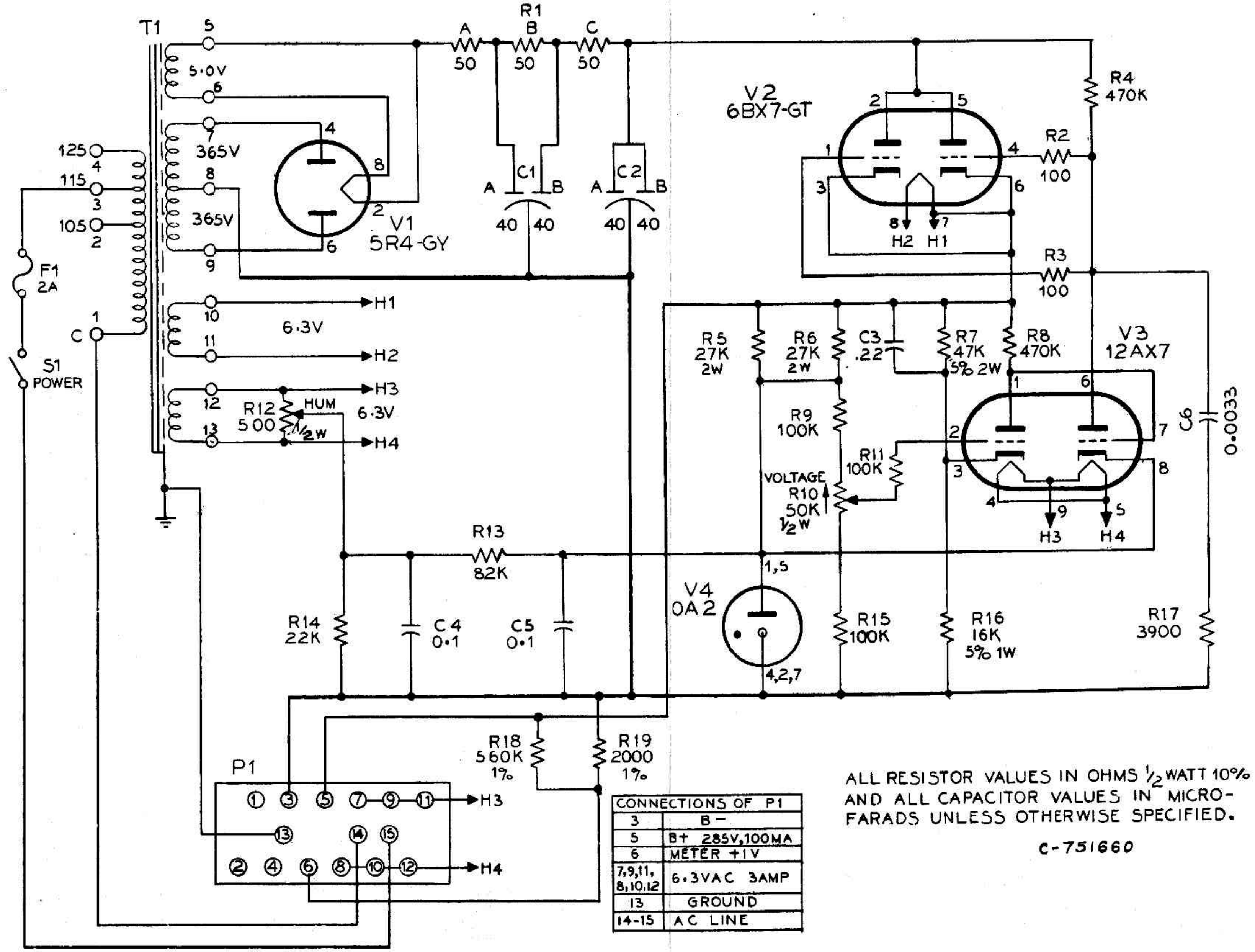


Figure APS-3. Connection Diagram



CONNECTIONS OF P1	
3	B−
5	B+ 285V,100MA
6	METER +1V
7,9,11, 8,10,12	6.3VAC 3AMP
13	GROUND
14-15	AC LINE

ALL RESISTOR VALUES IN OHMS ½ WATT 10% AND ALL CAPACITOR VALUES IN MICRO-FARADS UNLESS OTHERWISE SPECIFIED.

C-751660

Figure APS-4. Schematic Diagram

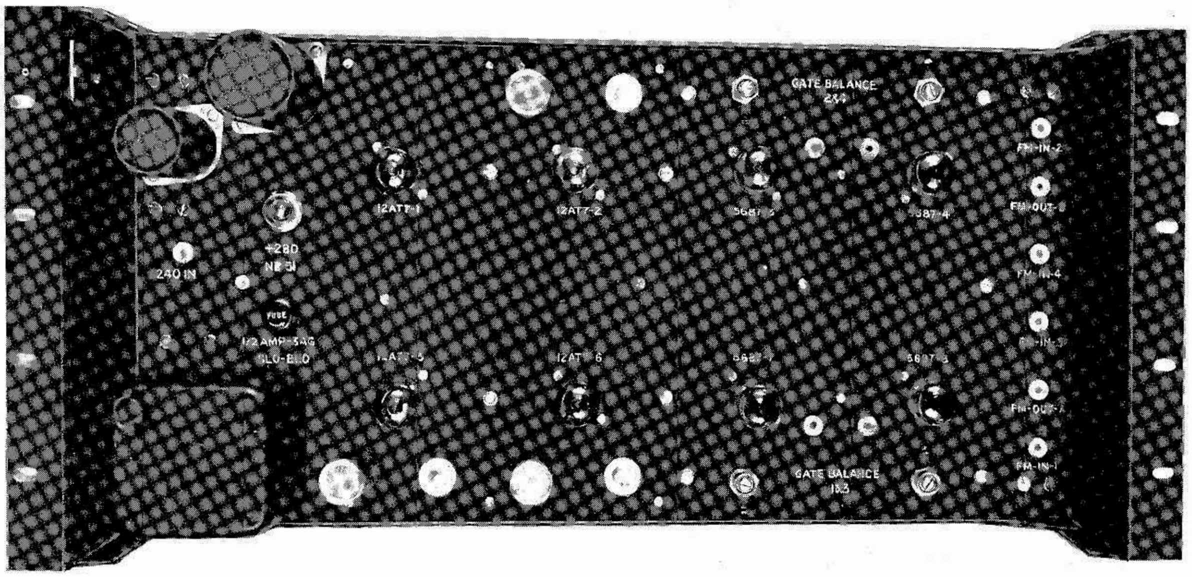


Figure SW-2. 4 x 2 Switcher, Front View

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles, 35 watts (from circuit breaker no. 2)

DC: 280 volts, 155 ma (from power supply no. 1, unit 409)

Inputs

FM signals 1, 2, 3, and 4: 0.5 volt peak-to-peak, nominal (from equalizer, unit 105)

240-cycle reference pulse: 4 volts peak-to-peak, approximately (from tonewheel amplifier, unit 505)

Input Impedance

160 ohms

Outputs

FM signals "A" and "B": 0.25 volt peak-to-peak, nominal (to 2 x 1 switcher, unit 309)

Output Impedance

160 ohms

Frequency Response

Flat ±10% from 1 to 9 mc

Fuse

½ ampere, slo-blo, 3AG

Tube and Diode Complement

Tubes: 4 — 12AT7
4 — 5687

Diodes: 28 — 1N54A

DESCRIPTION

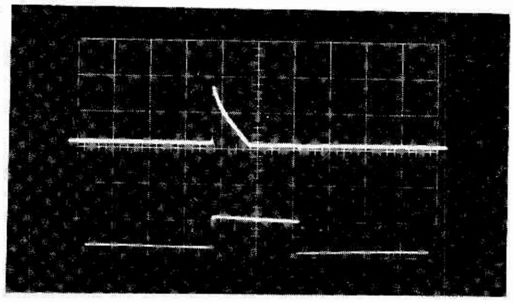
The 4 x 2 switcher (unit 207) combines four separate fm signals from the equalizer (unit 105) into two fm signals "A" and "B" which are fed to the 2 x 1 switcher (unit 309). (Refer to block diagram, figure SW-1.) A 240-cycle tonewheel reference pulse is used to control two pairs of six-diode gates so that switching occurs in the proper timing sequence.

Circuit

Four individual fm signals from the equalizer are fed to separate input jacks on the 4 x 2 switcher chassis as shown on the schematic diagram, figure SW-12. Input signals 1 and 3 are combined into fm signal "A" by one pair of six-diode gates, while input signals 2 and 4 are combined into fm signal "B" by the other pair. The outputs of video heads which are 180° apart are combined, since these heads never come in contact with the tape simultaneously.

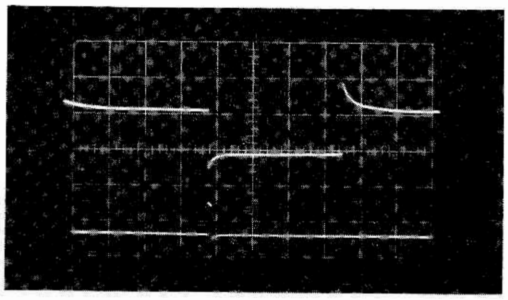
The diode gates are controlled by a series of switching pulses generated by multivibrators. A delay multivibrator is used to shift the switching pulses which control the diode gates for heads 1 and 3 along the time axis so that they coincide with the head signals. The multivibrators are triggered by a 240-cycle tonewheel reference pulse to insure switching at the required intervals.

The 240-cycle reference pulse is applied to the 4 x 2 switcher chassis at jack J2 and may be observed at test point TP1 (240 IN). The pulse, having an amplitude of approximately four volts, is amplified and shaped by buffer amplifier and differentiator V1 before being

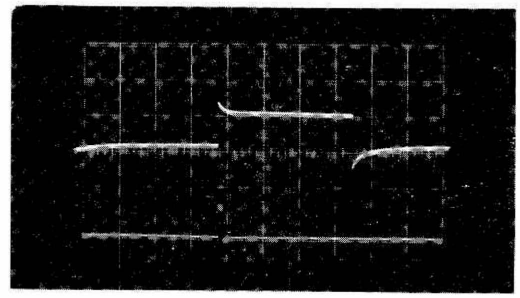


***Top:* Differentiated Reference Pulse Used to Trigger Multivibrators V5 and V2.**
***Bottom:* 240-cycle Reference Pulse at TP1 (240 IN).**

Figure SW-3.

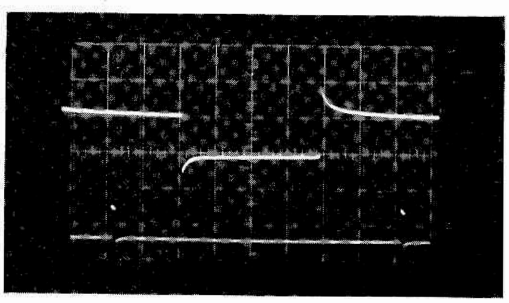


A. Square Wave at V3 pin 1 (TP2)

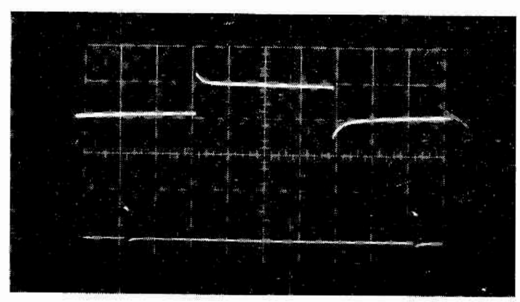


B. Square Wave at V3 pin 9 (TP3)

Figure SW-4. Square Waves Applied Simultaneously to Gates 2 and 4



A. Square Wave at V7 pin 1 (TP4)



B. Square Wave at V7 pin 9 (TP5)

Figure SW-5. Square Waves Applied Simultaneously to Gates 1 and 3

fed to multivibrator V2 and delay multivibrator V5 simultaneously (figure SW-3).

When multivibrator V2 is triggered, it produces a square wave output which is fed to amplifier and phase-splitter V3. Each half of phase-splitter V3 delivers a square wave to a pair of six-diode gates which control the switching of fm signals 2 and 4. The square waves are equal in amplitude and duration but opposite in polarity, so that both positive and negative-going control signals are fed simultaneously to the gates (figure SW-4).

Delay multivibrator V5 is used to delay the triggering pulse 90° or 1043 microseconds (one half the triggering pulse interval) so that multivibrator V6 is triggered at the proper time to coincide with video head signals 1 and 3. The square wave produced by V6 is fed to amplifier and phase-splitter V7 which provides the switching circuit with control signals used in switching fm signals 1 and 3 (figure SW-5).

The four fm input signals are fed directly to one of two switching circuits, each circuit consisting of

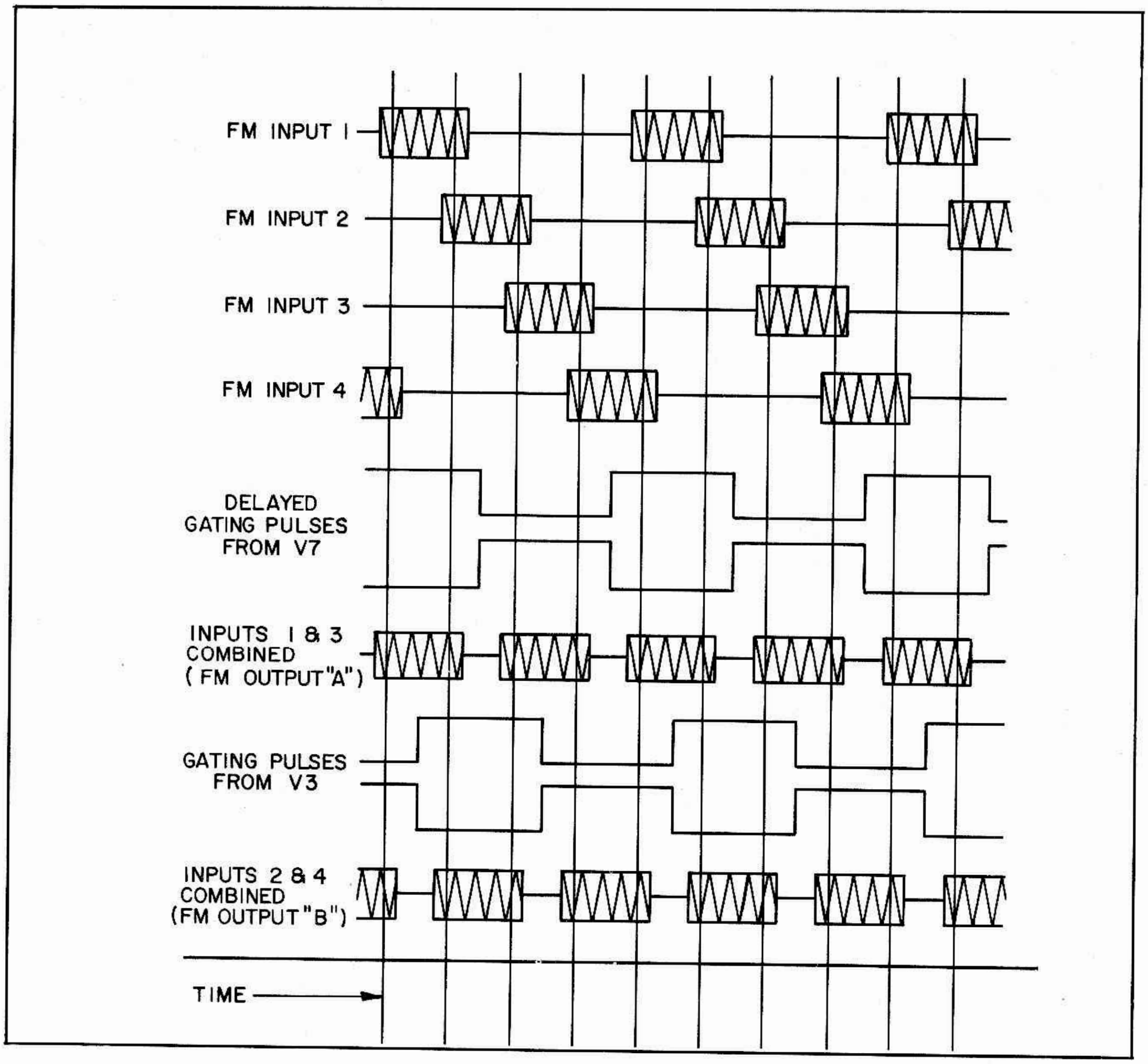
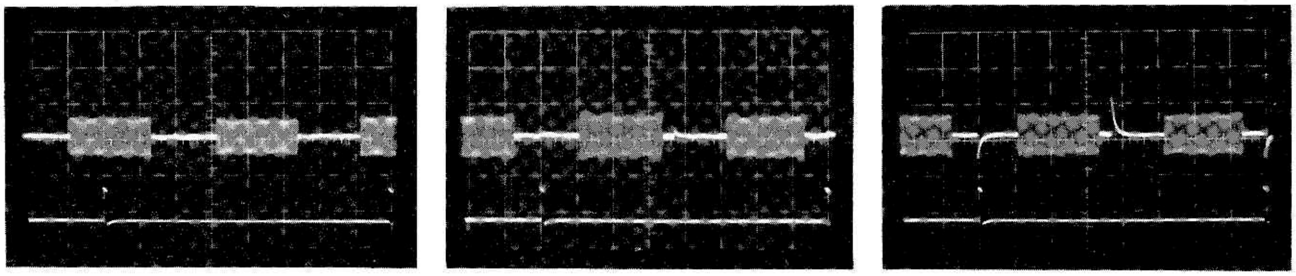


Figure SW-6. Combining Action of Diode Gates

a pair of diode gates. Each gate contains six crystal diodes which are polarized by the 280 volt dc B+ voltage. Gate input and output capacitors prevent the dc potentials on the diodes from being affected by source or load. Control signals of opposite polarity are fed to the gating diodes of each gate (CR9/CR10, CR11/CR12, etc.) providing a bias voltage which causes them to conduct or not conduct, according to the polarity of the control signals. When the gating diodes are conducting, a reverse bias voltage is applied to the four remaining diodes, thus cutting them off and "closing" the gate so that the fm signal will not be passed. Simultaneously, the gating diodes of the second gate of the pair receive control signals of opposite polarity which cut them off, thus allowing the four remaining diodes to conduct and pass the fm signal. It should be noted that both positive and negative-going signals must be applied simultaneously to each gate to open or close the gate. Figure SW-6 illustrates the combining action of the gate circuits. Balance potentiometers are provided in each gate circuit to balance the dc voltage so that switching spikes are minimized. (Refer to *Maintenance*).

The fm signals thus combined are amplified by totem-pole type amplifiers V4 and V8 and fed as fm output "A" and fm output "B" to the 2 x 1 switcher. Figures SW-7A and SW-7B show the output waveforms which may be observed at test points TP10 and TP7.



A. FM Output A at TP10

B. FM Output B at TP7 (Balance Controls Correctly Adjusted)

C. FM Output B at TP7 (Balance Controls Incorrectly Adjusted)

Figure SW-7. FM Output Signals (0.5 volt/cm; 500 usec/cm)

MAINTENANCE

Balance Control Adjustment

The gate balance controls should be adjusted periodically by the following procedure:

1. Place the tape recorder in PLAY mode.

2. With the waveform monitor (unit 306) input selector switch in TEST position, connect the input probe to test point TP10 (FM-OUT-A). (An external oscilloscope may be used in place of the waveform monitor).

3. Alternately adjust channel 1 and 3 balance controls (GATE BALANCE 1 & 3) for minimum spikes between fm signals, while maintaining base-line continuity. (See figure SW-7A.)

4. Move oscilloscope input probe to test point TP7 (FM-OUT-B) and repeat step 3, alternately adjusting channel 2 and 4 balance controls (GATE BALANCE 2 & 4). Figures SW-7B and SW-7C show channel 2 and 4 balance controls correctly and incorrectly adjusted.

> NOTE: Steps 2, 3 and 4 above may also be performed after placing the machine in WIND and adjusting the variable FORWARD-REVERSE control so that there is no tape motion. In this condition the fm signals are not present and base-line continuity may be easily observed while adjusting for minimum spikes.

Frequency Response

The frequency response of fm output signals A and B should be flat ($\pm 10\%$) from 1 to 9 mc. The procedure outlined below provides a method of checking the frequency response of the unit. A list of test equipment required consists of the following:

1. Video sweep generator (0 to 10 mc sweep).

2. Wide-band oscilloscope (Tektronix Type 535 or equivalent).

To check the frequency response, proceed as follows:

1. Remove the coax cable from jack J8 (FM-IN-1) and remove square wave multivibrator V6.

2. Connect the sweep generator to J8 and adjust the generator output to 1 volt peak-to-peak.

3. Connect the oscilloscope to test point TP7 or jack J6 (FM-IN-A) of the 2 x 1 switcher (unit 309) and observe the frequency response. If the frequency response requirement noted above is not met, check output tube V8 and associated circuit components.

4. Replace coax cable and tube.

5. Remove coax cable from jack J3 (FM-IN-2) and remove square wave multivibrator V2.

6. Connect the sweep generator to J3 and adjust the generator output to 1 volt peak-to-peak.

7. Connect the oscilloscope to test point TP8 or jack J7 (FM-IN-B) of the 2 x 1 switcher and observe the frequency response. If the frequency response requirements are not met, check output tube V4 and associated circuit components.

8. Replace coax cable and tube.

Gain

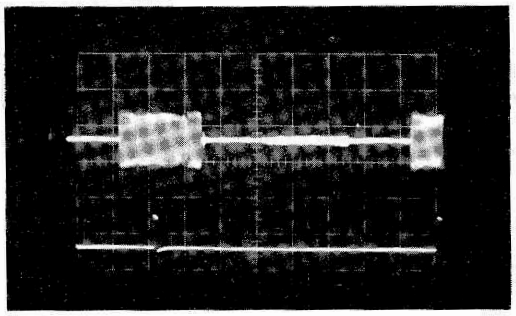
The fm output signal amplitude, at 1 megacycle, should be not less than one half the input signal amplitude when checked by placing the machine in PLAY mode and comparing the input signal at test point TP11 (FM-IN-1) with the output signal at test point TP10 (FM-OUT-A) for channel A. For channel B, compare the input and output signal amplitudes at test points TP6 (FM-IN-2) and TP7 (FM-OUT-B) respectively. The waveform monitor, with input selector switch in TEST position and probe connected to the appropriate test point, may be used in comparing the input and output signals.

If the output signal amplitude of either channel is less than one half the input signal amplitude, check the output tube (V8 or V4) and associated circuit components.

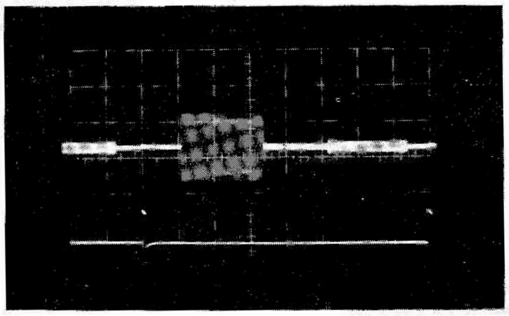
Waveforms and Voltages

Figures SW-8 to SW-10 show typical waveforms obtained throughout the unit with a Tektronix Type 535 oscilloscope, with amplitudes and oscilloscope horizontal sweep rates noted. In each figure the recorder is in the PLAY mode and the 240-cycle reference pulse is shown.

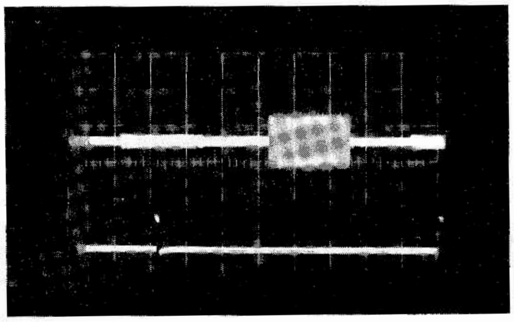
The *Voltage Table,* adjacent to the schematic diagram (figure SW-12), shows typical voltages from tube-sockets to ground obtained with a vacuum-tube voltmeter. All voltages are dc unless otherwise noted.



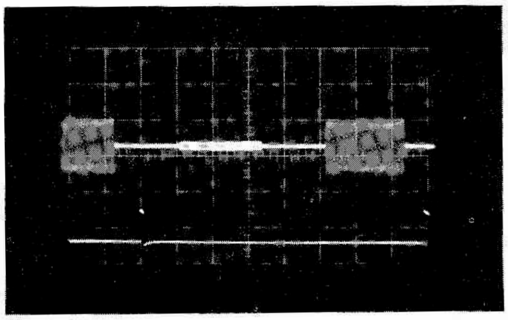
A. FM-IN-1 (TP11); 0.5 volt/cm, 500 usec/cm



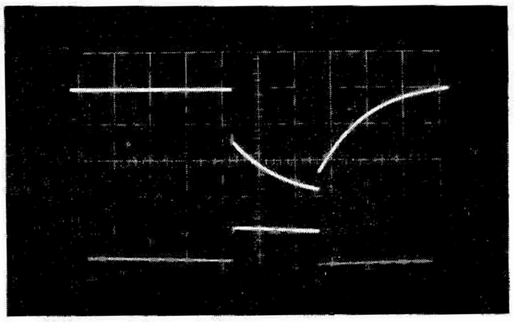
B. FM-IN-2 (TP6); 0.5 volt/cm, 500 usec/cm



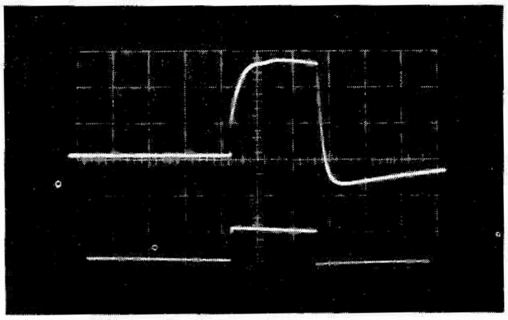
C. FM-IN-3 (TP9); 0.5 volt/cm, 500 usec/cm



D. FM-IN-4 (TP8); 0.5 volt/cm, 500 usec/cm

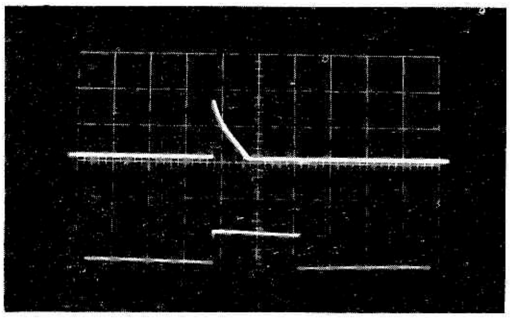


E. V1 pin 1; 20 volts/cm, 20 usec/cm

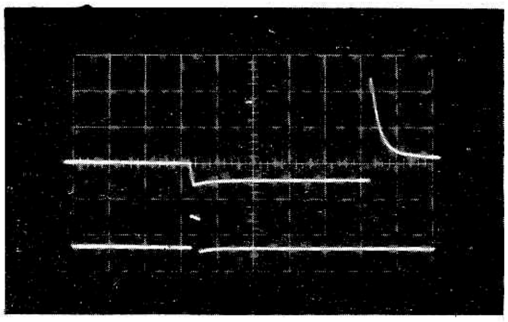


F. V1 pin 6; 20 volts/cm, 20 usec/cm

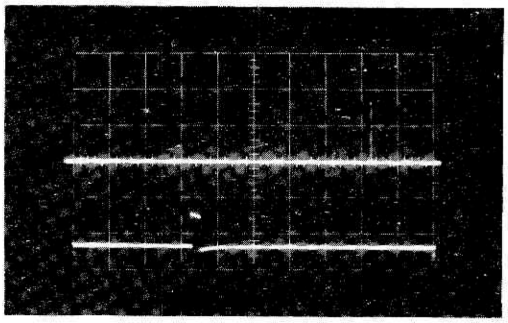
Figure SW-8. Typical Waveforms



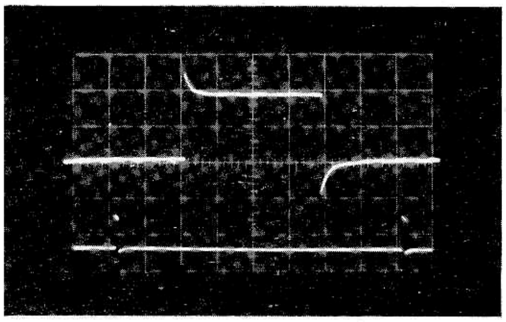
A. V5, V2 pin 2; 10 volts/cm, 20 usec/cm



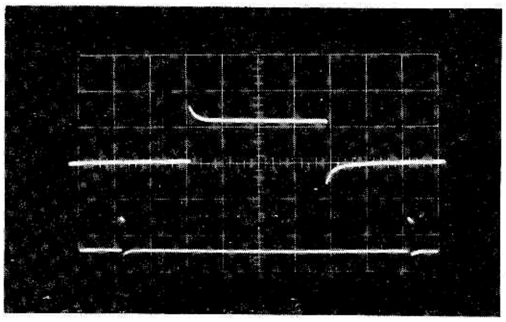
B. V5 pin 3; 20 volts/cm, 200 usec/cm



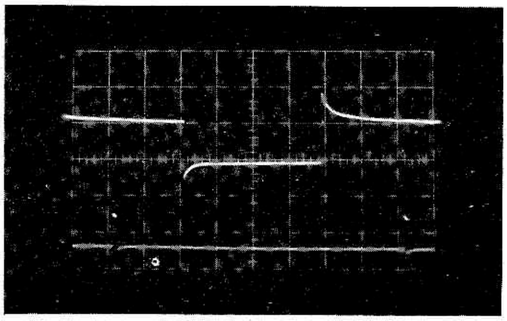
C. V6 pin 2; 10 volts/cm, 200 usec/cm



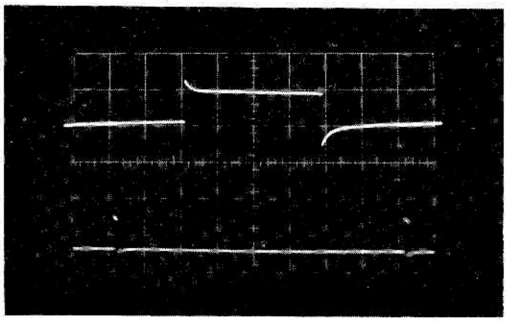
D. V6 pin 6; 100 volts/cm, 200 usec/cm



E. V7 pin 2; 5 volts/cm, 500 usec/cm

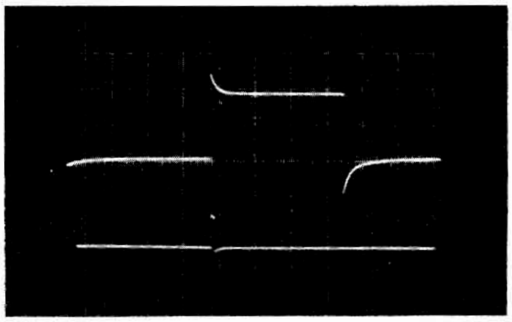


F. V7 pin 1 (TP4); 20 volts/cm, 500 usec/cm

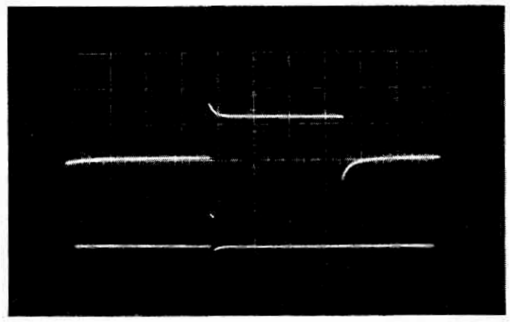


G. V7 pin 9 (TP5); 20 volts/cm, 500 usec/cm

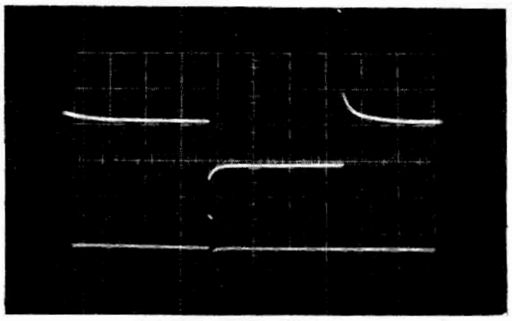
Figure SW-9. Typical Waveforms



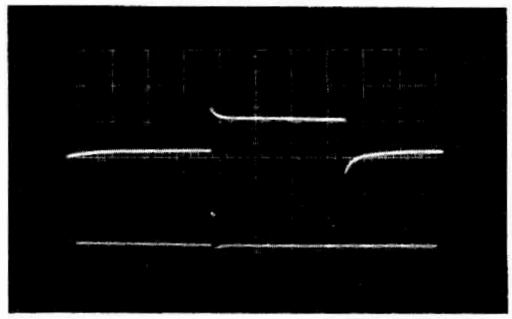
A. V2 pin 6; 100 volts/cm, 500 usec/cm



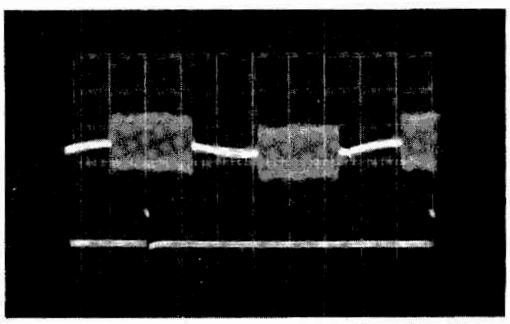
B. V3 pin 2; 5 volts/cm, 500 usec/cm



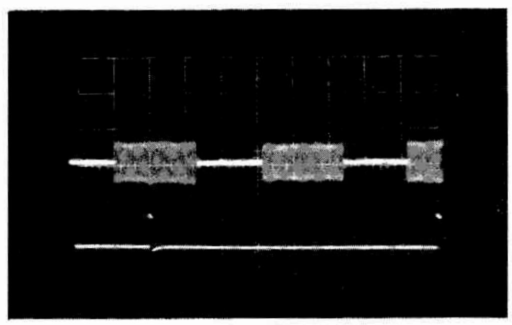
C. V3 pin 1 (TP2); 20 volts/cm, 500 usec/cm



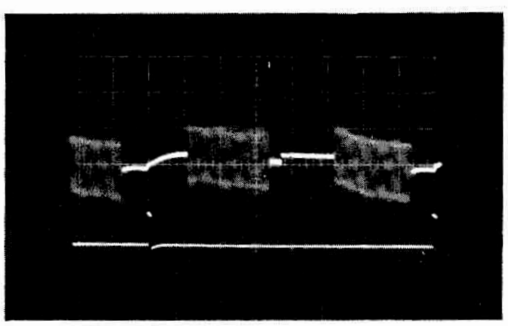
D. V3 pin 9 (TP3); 20 volts/cm, 500 usec/cm



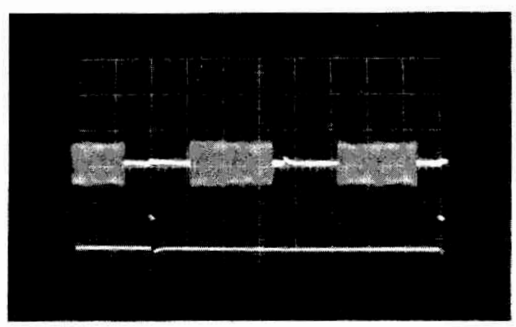
E. V8 pin 2; 0.5 volt/cm, 500 usec/cm



F. FM-OUT-A (TP10); 0.5 volt/cm, 500 usec/cm



G. V4 pin 2; 0.5 volt/cm, 500 usec/cm



H. FM-OUT-B (TP7); 0.5 volt/cm, 500 usec/cm

Figure SW-10. Typical Waveforms

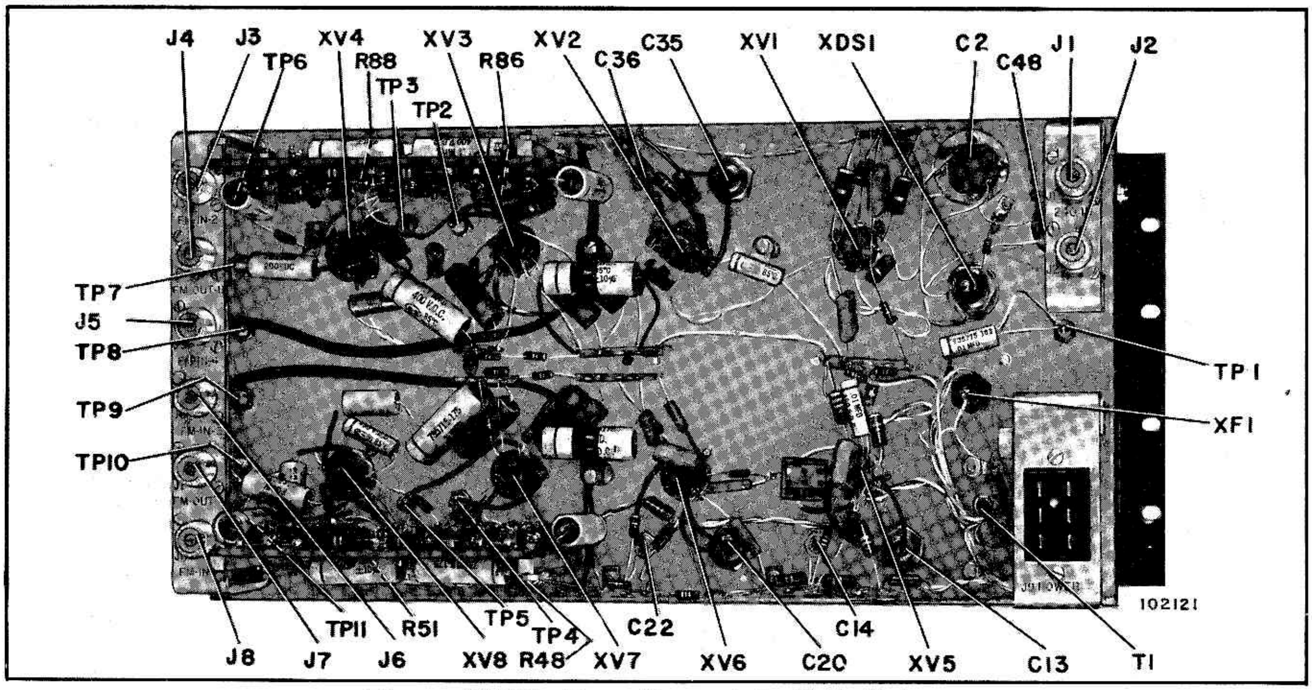


Figure SW-11. Rear View of 4 x 2 Switcher

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			4 X 2 SWITCHER (8957405-501) 13
			CAPACITORS:
C1		735715-163	paper, 0.01 μf ±10%, 400 v
C2A/B	209267	458558-2	electrolytic, 1000/1000 μf +250 -10%, 15 v
C3		727871-167	mica, 6800 $\mu\mu$f ±10%, 300 v char "B"
C4		727871-147	mica, 1000 $\mu\mu$f ±10%, 500 v char "B"
C5		735715-163	paper, 0.01 μf ±10%, 400 v
C6 to C12			Not Used
C13	214735	8814169-5	paper, 1 μf ±10%, 150 v
C14	206480	737863-137	paper, 1 μf ±10%, 200 v
C15		727871-167	mica, 6800 $\mu\mu$f ±10%, 300 v char "B"
C16		727856-240	mica, 510 $\mu\mu$f ±5%, 500 v char "B"
C17		727856-131	mica, 220 $\mu\mu$f ±10%, 500 v char "B"
C18		727856-127	mica, 150 $\mu\mu$f ±10%, 500 v char "B"
C19		727871-167	mica, 6800 $\mu\mu$f ±10%, 300 v char "B"
C20	214735	8814169-5	paper, 1 μf ±10%, 150 v
C21		727871-268	mica, 7500 $\mu\mu$f ±5%, 300 v char "B"
C22	206480	737863-137	paper, 1 μf ±10%, 200 v
C23 to C28		735715-175	paper, 0.1 μf ±10%, 400 v
C29		735715-163	paper, 0.01 μf ±10%, 400 v
C30,C31	206322	737818-15	paper, 0.22 μf ±10%, 100 v
C32	212473	737818-55	paper, 0.22 μf ±10%, 200 v
C33,C34			Not Used
C35	214735	8814169-5	paper, 1 μf ±10%, 150 v
C36	206480	737863-137	paper, 1 μf ±10%, 200 v
C37		727871-268	mica, 7500 $\mu\mu$f ±5%, 300 v char "B"
C38 to C43		735715-175	paper, 0.1 μf ±10%, 400 v
C44		735715-163	paper, 0.01 μf ±10%, 400 v
C45	206322	737818-15	paper, 0.22 μf ±10%, 100 v
C46	212473	737818-55	paper, 0.22 μf ±10%, 200 v
C47	206322	737818-15	paper, 0.22 μf ±10%, 100 v
C48A/B	99295	458557-5	electrolytic, 20/20 μf +50 -10%, 450 v
C49,C50		735715-175	paper, 0.1 μf ±10%, 400 v

Symbol No.	Stock No.	Drawing No.	Description
C51		735715-163	paper, 0.01 μf ±10%, 400 v
C52, C53		8811182-5	ceramic, 10,000 μf +100 -20%, 450 v
C54		735715-179	paper, 0.22 μf ±10%, 400 v
CR1	99483		Diode: type 1N54A
CR2			Not Used
CR3, CR4	99483		Diode: type 1N54A
CR5 to CR29	99483	8981515-3	Diode: type 1N54A
DS1	101857	872291-9	Lamp: neon, NE51
F1	212327	990157-106	Fuse: 1/2 amp
J1 to J8	51800	255223-2	Connector: coax, chassis mtg.
J9	51604	727969-3	Connector: male, 6 contact, chassis mtg.
P1	215661	252868-1	Connector: coax
	54246	893648-2	Adapter: solder type
P2	215661	252868-1	Connector: coax
P3 to P8	215661	252868-1	Connector: coax
		8979037-1	Adapter only
		8979036-2	Sleeve only
P9	51607	727969-4	Connector: female, 6 contact, cable mtg.
			RESISTORS:
			Fixed, composition - unless otherwise specified
R1		82283-94	470,000 ohm ±10%, ½ w
R2		82283-52	150 ohm ±10%, ½ w
R3		90496-66	2200 ohm ±10%, 1 w
R4		99126-70	4700 ohm ±10%, 2 w
R5		82283-66	2200 ohm ±10%, ½ w
R6		82283-52	150 ohm ±10%, ½ w
R7		82283-54	220 ohm ±10%, ½ w
R8		99126-70	4700 ohm ±10%, 2 w
R9		82283-77	18,000 ohm ±10%, ½ w
R10		82283-92	330,000 ohm ±10%, ½ w
R11 to R19			Not Used
R20		90496-195	33,000 ohm ±5%, 1 w
R21		90496-206	91,000 ohm ±5%, 1 w
R22		90496-84	68,000 ohm ±10%, 1 w
R23		82283-216	240,000 ohm ±5%, ½ w
R24		90496-194	30,000 ohm ±5%, 1 w
R25		90496-66	2200 ohm ±10%, 1 w
R26		82283-74	10,000 ohm ±10%, ½ w
R27		90496-77	18,000 ohm ±10%, 1 w
R28		90496-193	27,000 ohm ±5%, 1 w
R29		90496-204	75,000 ohm ±5%, 1 w
R30		82283-92	330,000 ohm ±10%, ½ w
R31		82283-93	390,000 ohm ±10%, ½ w
R32		82283-230	910,000 ohm ±5%, ½ w
R33		82283-94	470,000 ohm ±10%, ½ w
R34		82283-159	1000 ohm ±5%, ½ w
R35		90496-194	30,000 ohm ±5%, 1 w
R36		90496-66	2200 ohm ±10%, 1 w
R37		82283-94	470,000 ohm ±10%, ½ w
R38		82283-52	150 ohm ±10%, ½ w
R39	59926	458572-73	wire wound, 7000 ohm ±5%, 5 w
R40		82283-50	100 ohm ±10%, ½ w
R41	94554	8817659-31	wire wound, 2000 ohm ±5%, 5 w
R42	59926	458572-73	wire wound, 7000 ohm ±5%, 5 w
R43		82283-52	150 ohm ±10%, ½ w
R44		82283-94	470,000 ohm ±10%, ½ w
R45, R46		82283-140	160 ohm ±5%, ½ w
R47		99126-78	22,000 ohm ±10%, 2 w
R48	205045	8971860-112	variable, comp., 25,000 ohm ±10%, 2 w
R49		90496-78	22,000 ohm ±10%, 1 w
R50		99126-78	22,000 ohm ±10%, 2 w
R51	205045	8971860-112	variable, comp., 25,000 ohm ±10%, 2 w
R52		90496-78	22,000 ohm ±10%, 1 w
R53 to R56		82283-54	220 ohm ±10%, ½ w
R57		82283-64	1500 ohm ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R58		90496-60	680 ohm ±10%, 1 w
R59		82283-137	120 ohm ±5%, ½ w
R60		82283-94	470,000 ohm ±10%, ½ w
R61,R62		82283-145	270 ohm ±5%, ½ w
R63			Not Used
R64		82283-92	330,000 ohm ±10%, ½ w
R65		90496-193	27,000 ohm ±5%, 1 w
R66		90496-204	75,000 ohm ±5%, 1 w
R67		82283-93	390,000 ohm ±10%, ½ w
R68		82283-230	910,000 ohm ±5%, ½ w
R69		82283-94	470,000 ohm ±10%, ½ w
R70		82283-159	1000 ohm ±5%, ½ w
R71		90496-194	30,000 ohm ±5%, 1 w
R72		90496-66	2200 ohm ±10%, 1 w
R73		82283-94	470,000 ohm ±10%, ½ w
R74		82283-52	150 ohm ±10%, ½ w
R75	59926	458572-73	wire wound, 7000 ohm ±5%, 5 w
R76		82283-50	100 ohm ±10%, ½ w
R77	94554	8817659-31	wire wound, 2000 ohm ±5%, 5 w
R78		82283-52	150 ohm ±10%, ½ w
R79		82283-94	470,000 ohm ±10%, ½ w
R80	59926	458572-73	wire wound, 7000 ohm ±5%, 5 w
R81,R82		82283-140	160 ohm ±5%, ½ w
R83,R84		90496-78	22,000 ohm ±10%, 1 w
R85		99126-78	22,000 ohm ±10%, 2 w
R86	205045	8971860-112	variable, comp., 25,000 ohm ±10%, 2 w
R87		99126-78	22,000 ohm ±10%, 2 w
R88	205045	8971860-112	variable, comp., 25,000 ohm ±10%, 2 w
R89 to R92		82283-54	220 ohm ±10%, ½ w
R93		82283-64	1500 ohm ±10%, ½ w
R94		90496-60	680 ohm ±10%, 1 w
R95		82283-137	120 ohm ±5%, ½ w
R96		82283-145	270 ohm ±5%, ½ w
R97		82283-94	470,000 ohm ±10%, ½ w
R98		82283-145	270 ohm ±5%, ½ w
R99			Part of XDS1
R100		82283-94	470,000 ohm ±10%, ½ w
R101		90496-111	10 ohm ±5%, 1 w
T1	58619	895326-4	Transformer: filament
TP1 to TP11	208983	8825493-7	Jack: tip
XADS1	208080	990788-507	Jewel
XDS1	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XV1 to XV8	94926	737870-14	Socket: tube, 9 pin

VOLTAGE TABLE†

Tube Symbol	Tube Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V1	12AT7	260	0	5	*	*	230	−0.15	1.8	NC
V2	12AT7	240	80	86	*	*	170	−8	7	NC
V3	5687	170	56	68	*	*	68	58	NC	170
V4	5687	260	130	133	*	*	4	0	NC	130
V5	12AT7	250	70	80	*	*	150	2.7	15	NC
V6	12AT7	250	82	90	*	*	180	−10	7	NC
V7	5687	160	58	70	*	*	70	58	NC	160
V8	5687	260	132	140	*	*	4.5	0	NC	132

* 12.6 volts ac between pins 4 and 5.

† Voltages measured from tube-socket pins to ground with vacuum-tube voltmeter. All voltages dc unless otherwise noted.

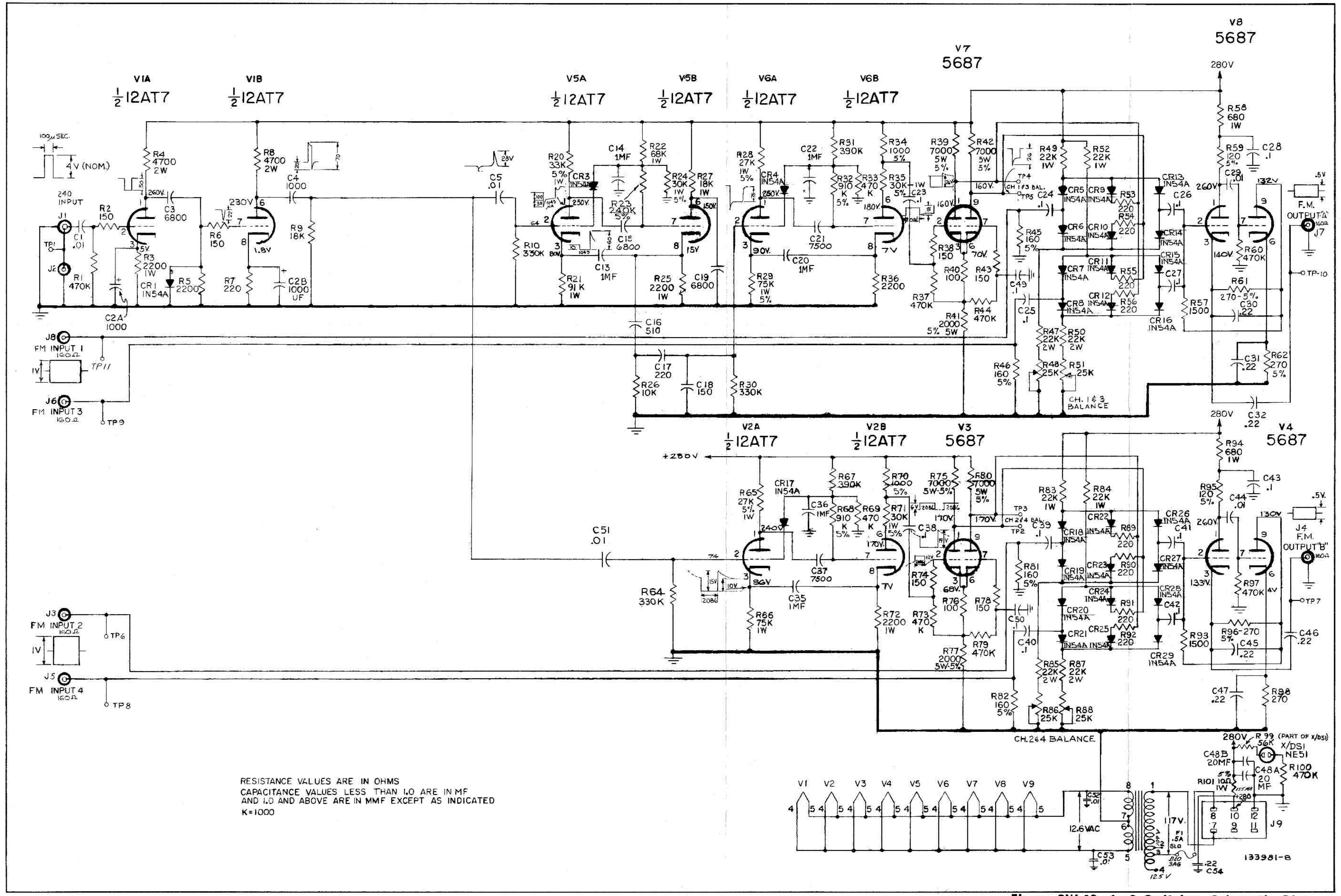


Figure SW-12. 4 x 2 Switcher, Schematic Diagram

Headwheel Blower

UNIT 208

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 671

IB-31178

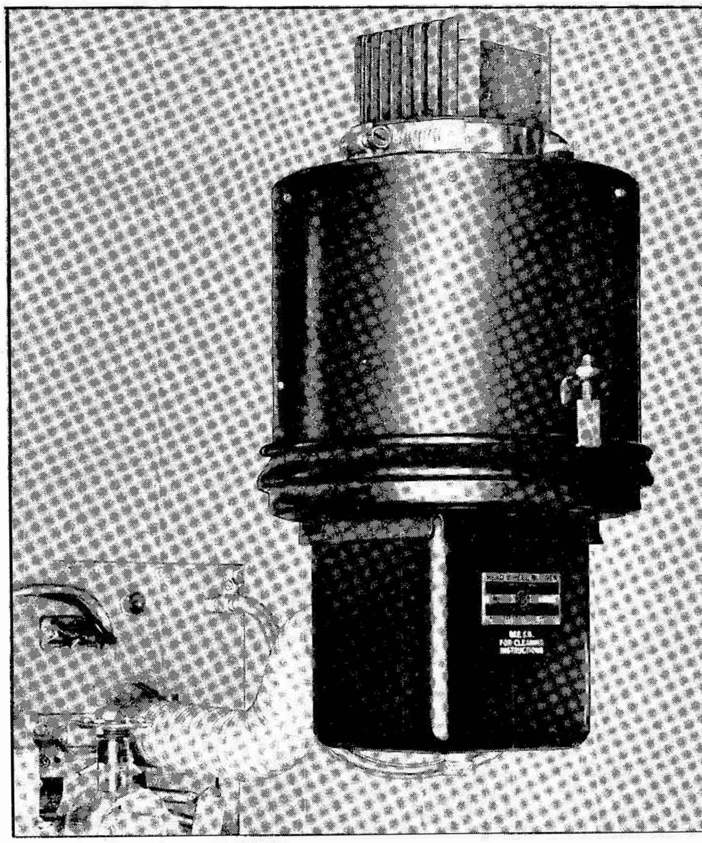


Figure HWB-1. Headwheel Blower

DESCRIPTION

The function of the Headwheel Blower (Unit 208) is to draw air over the headwheel motor for both cleaning and cooling. A permanently lubricated ball bearing motor drives a multi-stage blower which draws the air from the headwheel panel over an oil-wetted wire filter. This filter removes dust and lint collected from the tape and headwheel.

MAINTENANCE

The only maintenance required is a regular cleaning of the filter. It should be cleaned every month under average operating conditions. The procedure to be used for cleaning the filter is as follows:

1. Loosen the hose clamp on the rear of the rectangular filter chamber, located at the bottom of the assembly, and then disengage the hose connecting this unit to the headwheel panel.

2. Hold the rectangular filter chamber with one hand, and remove the knurled nut at the bottom of the chamber. Then remove the chamber by lowering it until it is clear of the filter.

3. While holding the bottom ring of the filter remove the second knurled nut at the bottom of the filter.

4. Remove both the bottom ring and the woven wire filter by moving it down to clear the mounting stud. A gasket in the top ring of the filter assembly may also come off when the wire filter is removed; the remaining parts of the filter assembly are restrained from falling by the legs of the "Y" type mounting stud. It is not necessary to remove these for cleaning.

NOTE: If the removal of the remaining parts of the filter assembly is necessary for repairs, first remove the "Y" stud by compressing it until one leg has cleared the hole in the housing, and then the remaining parts will drop off.

5. Wash the wire filter element using chlorethene or kerosene. Let the filter element dry, and then dip it in motor oil (SAE 20-30). Allow the excess oil to drain off preferably overnight, before reassembling.

6. To reassemble the headwheel blower reverse the procedure given in steps 1 through 4.

7. Measure the vacuum pressure with a manometer. The blower should develop a minimum pressure of 5½ inches of water when there is no air flow. Block off all air flow when making this measurement.

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
HEADWHEEL MOTOR BLOWER (8974475-501)			
B1			Motor: part of Blower Assembly
C1	218266	8978089-1	Capacitor: paper, 4 μf ±10%, 330 v A.C.
			Miscellaneous:
	218294		Blower: 115 v, 50/60 cycle, including motor symbol B1, less filter
	218270	8439065-501	Clamp: "Y" type, filter and cover retaining
	218269	8439077-501	Cover: blower air filter
	218293		Filter: oil wetted air
	218268	8978073-1	Gasket: synthetic rubber, oil resistance, 4.27" x 4.27"
	218267	8978072-1	Washer: cork rubber, adhesive coated, 3.38" O.D. x 2.25" I.D.

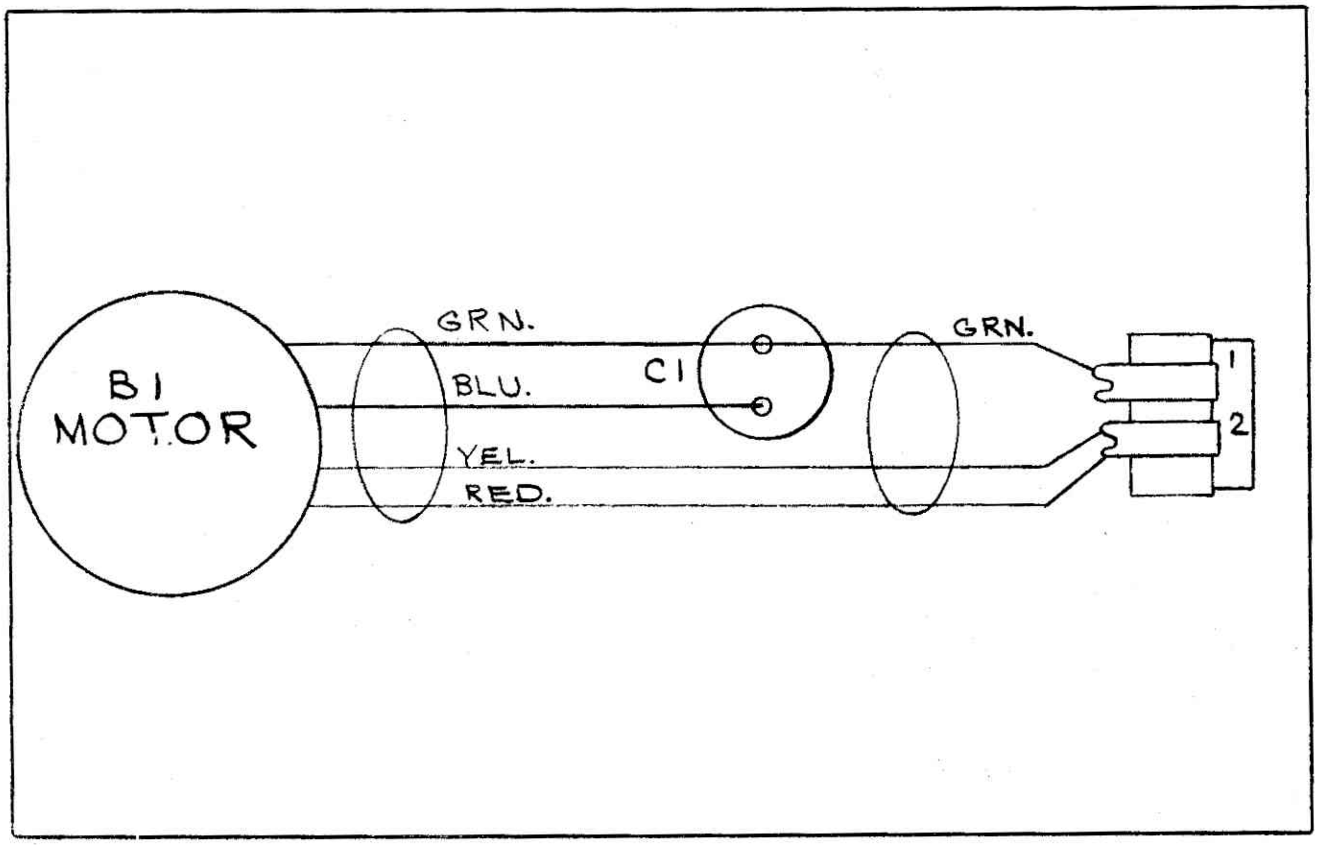
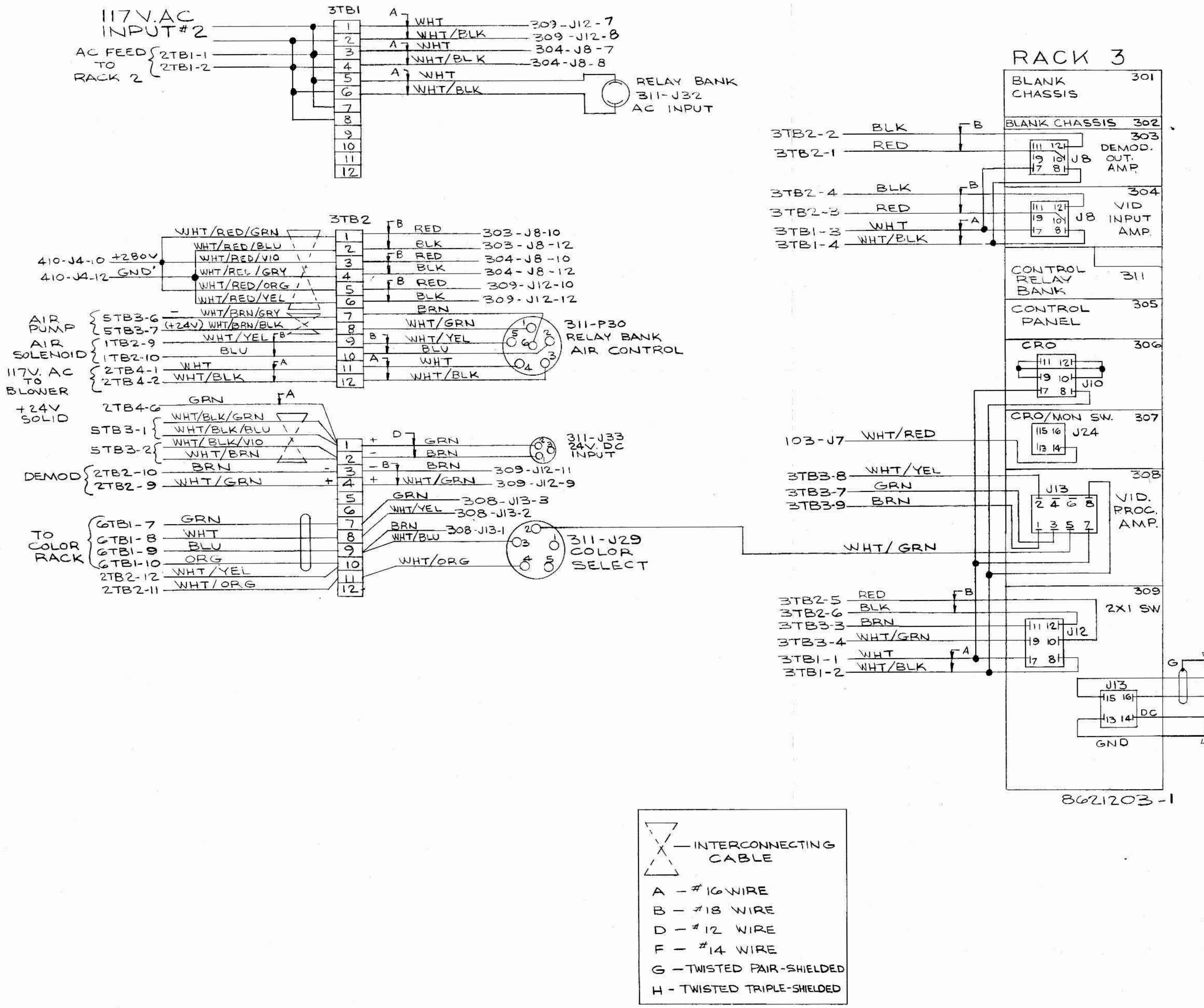


Figure HWB-2. Headwheel Blower Schematic Diagram

PARTS LIST

Symbol No.	Stock No.	Drawing No.	Description
RACK #3 (8975563-503)			
3TB1 to 3TB3		449691-5	Board: terminal



CONTROL PANEL & RELAY BANK
CABLE LIST

FROM		TO
305-J1	VID REC I	REC AMP 104-J2
305-J2	AUD./CUE	AUD PAN 204-P9, 204-P10
305-J3	AUD./CUE REC/PLAY VU	AUD PAN 204-P9, 204-P10
305-J4	OUTPUT	
305-J5	AUD CUE ATTEN.	AUD PAN 204-P9, 204-P10
305-J6	OUT	
305-J7	AUD. ERASE	AUD 205C-J1
305-J8	CUE ERASE	AUD 205E-J1
305-J9	AUD/CUE ATTEN.	AUD PAN 204 P9 & P10
305-J10	MASTER ERASE	ERASE OSC 101-J1
305-J11	SPKR. OUT	AUD 206B-J1
305-J12	SPKR INPUT	AUD 206B-J2
305-J13	AUD. IN	
305-J14	CUE IN	
305-J15	CAPSTAN SERVO	CAP SERVO 404-P8
305-J16	GUIDE SERVO	GUIDE SERVO 506-J1
311-J21	TAPE PAN	200 TB2 & 3
311-J22	REF GEN	4TB2
311-J23	AUD/CUE JUN PAN	AUD PAN 204-J9
311-J24	MODULATOR	MOD 102-J1
311-J25	RECORD AMP	REC AMP 104-J3
311-J26	PLAYBACK AMP	109-J1
311-J27	DEMOD	201-J5
311-J28	ON AIR	
311-J29	COLOR SELECTOR	3TB2 & 308-J13
311-J30	AIR CONTROL	3TB2
311-J31	H.W. SERVO	5TB2
311-J32	A.C. INPUT	3TB1-5 & 6
311-J33	D.C. INPUT	3TB3-1 & 2

Interconnection Diagram, Rack 3

ELECTRONIC RECORDING PRODUCTS

Video Distribution Amplifier*

UNITS 303, 304

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

* Similar to Type TA-3C

IB-31124

PRINTED IN U.S.A.
PP 641

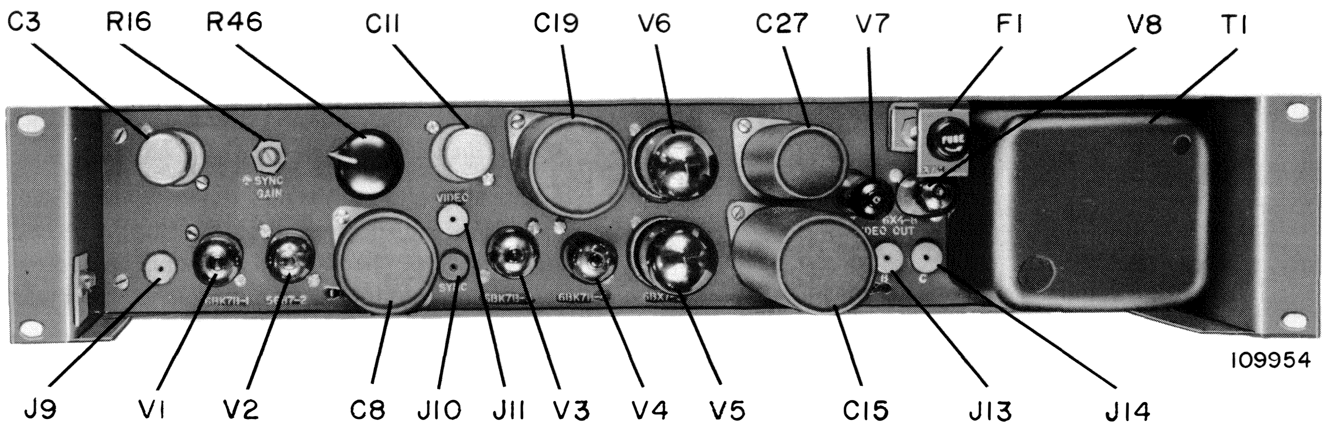


Figure DA-1. Video Distribution Amplifier

TECHNICAL DATA

Input Power AC

105 to 130 volts, 50/60 cycles, 55 watts, from C.B. #2

Input Power DC

280 volts, 150 ma (Regulated) ,
(Supplied by 280-V Power Supply #2 (410) to each amplifier)

Input Signal Levels

Composite Video: 1.0 volts peak-to-peak max.

Sync: 3.5 to 8.0 volts peak-to-peak

Gain

0.5 to 2.0 adjustable

Outputs

3 outputs

Output Impedance

75 ohms, internally terminated

Output Signal Levels

Composite Video: 1.0 volts peak-to-peak max.

Sync: zero to 0.4 volt peak-to-peak

Isolation

Between Adjacent Amplifier Chassis: 50 db throughout band pass

Between Output Lines at Midband: 40 db

Between Output Lines at 4 MC: 28 db

Sine Wave Frequency Response

1.0 cycle to 8 mc — flat ±0.3 db

0.5 cycle to 10 mc — flat ±1.0 db

Low Frequency Square Wave Tilt

1.5% max. at 60 cycles

Tube Complement

3 6BK7B
2 6BX7
1 5687
1 OB2
1 6X4

DESCRIPTION

Two Video Distribution Amplifiers, DA #1, unit 304 and DA #2, unit 303, provide for the distribution of the composite video signal for the TRT-1B System. Each unit has three low-impedance outputs, each connected into the video tape system. Three 75-ohm coaxial terminators are supplied for each unit to terminate the unused jacks. Up to 6 db gain with excellent linearity and stability is possible. The frequency response is uniform within 0.3 db from 1 cycle to 8 mc with less than 1.5% tilt on a 60-cycle square wave.

The system requires a composite video signal fed to the Modulator, unit 102 from DA #1; a non-composite video mixed with sync through jacks J3 and J4 may be fed through the distribution amplifier. The relay K1 may be ordered separately (RCA Stock #99155) and is essential if sync interlock is to be used for remote control of sync. The relay socket XK1 is provided on the rear of the chassis near the sync input jacks, J3 and J4.

Both units are mounted at the top of Rack 3 in the system. The system input composite video signal is applied to J1 on DA #1; J2 is terminated. The video signal is applied to J1 of DA #2 from the Demodulator, unit 201, through the 2X1 Switcher, unit 309; J2 is terminated. The output connections into the system are tabulated for each amplifier in the chart below:

Circuit

The video distribution amplifier has two cascaded negative feedback amplifiers, the first having a gain of approximately two, and the second, gain of about one. The input signal is fed to the grid of series amplifier V1, a 6BK7B tube, which drives another series amplifier V2, a 5687 tube. The output is coupled through C8 to the VIDEO GAIN control R16. Part of the output voltage is fed back to the cathode of V1 through R8 and C22. The degenerative effect of the feedback reduces the overall gain of the circuit and improves frequency response, linearity and stability. HF COMPENSATION C22, controls the amount of feedback at high frequencies and is used for adjustment of high frequency response. HF COMPENSATION C5 is also used for adjustment of high frequency response. HF COMPENSATION C5 is also used for response compensation by controlling the high frequency gain and phase characteristics of the amplifier.

The movable arm of VIDEO GAIN control R16, feeds the video signal of required level to the second feedback amplifier. In this circuit, series connected 6BK7B triode sections, V4a and V4b amplify the signal. The cathode follower V3B isolates the high input capacity of the output tubes V5 and V6 from the triode voltage amplifiers. The series-parallel arrangement of V5 and V6 provides adequate signal current swing to drive three 75-ohm transmission lines through matching and isolation networks. A fraction of the signal at the output is introduced into the cathode circuit of V4A for negative feedback. The low output impedance resulting from the use of negative feedback is necessary to achieve high isolation between output lines.

The series amplifier configuration used in this amplifier offers many advantages, over conventional types, in reduction of distortion and current requirements. Operation of this type of circuit is best explained by referring to V2 in the schematic diagram figure DA-5.

Fixed bias voltage from R6 and R12 is applied to V2B. The cathode bias from R9 applied to V2A is such that voltage drops across both tube sections are approximately equal. When a positive going signal is applied to the grid of V2B, its plate resistance decreases and current flows from the load R16–R17 through C8, R9 and V2B to ground. The increased flow of current through R9 increases bias on V2A, causing the plate resistance of this section to increase and allow still more current to flow from the load through V2B. On negative going signals, the process

Unit	*From — To*	*System Unit*
DA #1	J5 — J1 VID IN	Modulator (102)
	J6 — J1 VID INPUT	CRO Monitor Switcher (307)
	J7 — J1 VID INPUT	Color Monitor Switcher (601)
DA #2	J5 — J1 DEMOD OUT	CRO Monitor Switcher (307)
	J6 — J17 VIDEO IN	Processing Amplifier (308)
	J7 — J1 VIDEO IN	Burst Oscillator (605)

is reversed with current flowing into the load from B+.

The sync-mixing circuit uses the "A" section of V3, a 6KB7B tube. The high-impedance input to this amplifier makes it possible to loop sync signal through several amplifiers without producing appreciable distortion. The level of the sync signal that may be mixed with the video signal is adjustable from zero to a maximum of 0.4 volt at the output of the amplifier.

Fixed bias voltage is supplied by V8, a 6X4 tube, connected as a half-wave rectifier. The voltage is regulated by V7, an OB2 tube. In addition this regulated voltage is used to establish a zero d-c reference level at the gain control and at the three output jacks.

INSTALLATION

The amplifiers are shipped mounted in Rack 3 with all tubes in place. The input tap on power transformer T1 has been adjusted in each amplifier for 117 v line voltage by connecting the input tap lead to the primary terminal 3.

Power Connections

The terminals of the Jones plug P8 supplied with each amplifier are connected as follows:

Unit	*Terminals*	*Connections*
DA #1	7-8	AC Line
	10	280 v from J4, pin 1● (Power Supply #2, Rack 4)
	12	−280 v Gnd from J4, pin 2 (Power Supply #2, Rack 4)
DA #2	7-8	AC Line
	10	280 v from J5, pin 10 (Power Supply #2, Rack 4)
	12	−280 v Gnd from J5, pin 12 (Power Supply #2, Rack 4)

CAUTION: Do not apply plate voltage to the unit unless the 6X4 bias rectifier tube V8 is in place.

Whenever power is applied to the unit, the a-c line should be turned on first. Allowing sufficient time for the tube heaters to reach operating temperature and the bias supply to become operative before applying plate voltage. Allow sufficient time for the amplifier to become stabilized before making any adjustments.

WARNING

DO NOT LEAVE AC POWER ON FOR ANY LENGTH OF TIME WITHOUT TURNING ON DC POWER.

Signal Input

The video distribution amplifiers are connected into the system through J1 with the 75-ohm coaxial cable supplied. Connector J2 is terminated. This spare jack is provided to bridge the line to supply signals to another piece of equipment.

If the distribution amplifier has been connected to mix the sync signal with the video signal, the sync signal is connected to J3 or J4. The spare jack is used for bridging or termination. In both cases, video and sync, if the signals are looped through to one or more pieces of equipment, the end of the line must terminate in 75 ohms.

Signal Output

The output jacks J5, J6, J7 are connected by 75-ohm coaxial cables with the proper connectors to other units as indicated in the system interconnection diagrams. Refer to the overall system instruction book.

If all of the outputs are not used, terminate the unused output jacks in 75 ohms.

Sync Interlock Connections

A jumper has been installed between pins 5 and 6 of the relay socket XK-1, to permit non-interlocked operation without a relay in place. This jumper must be removed for sync interlock operation.

If a sync interlock relay is to be used for remote control of sync, connect the circuit, according to the type of operation desired, as follows:

1. *Common 24-volt system*

a. Connect pin 11 of P8 to a 24-volt d-c supply.

b. Connect pin 9 of P8 to the control circuit which will supply 24 volts d-c to actuate the relay.

2. *Grounded 24-volt system*

a. Connect pins 11 and 12 of P8 together.

b. Connect pin 9 of P8 to the control circuit which will supply 24 volts d-c to actuate the relay.

3. *Grounded 280-volt system*

a. Connect an 82,000 ohm, 2 watt resistor in series with the lead between the relay coil and pin 9 of J8. If the control voltage is other than 280 volts, the limiting resistor must be selected accordingly. The resistor should limit the current to 2.5 milliamperes.

On the terminal board near the relay socket blank terminals are available for mounting the limiting resistor.

b. Connect pins 11 and 12 of P8.

c. Connect pin 9 of P8 to the control circuit which will supply 280 volts d.c. to actuate the relay.

4. *Common 280-volt d-c system*

a. Install a limiting resistor as in step 3a.

b. Connect pins 10 and 11 of P8.

c. Connect pin 9 of P8 to the control circuit which will ground this pin to actuate the relay.

SETUP FOR OPERATION

Once installed and interconnected into the system, operation consists of adjusting the VIDEO GAIN control and, if used, the SYNC GAIN controls, to be sure the required output voltage is being produced.

CAUTION: Be sure to allow time for the unit to become stabilized before making any adjustments.

The CRO Waveform Monitor mounted in Rack 3 may be used to check this voltage as follows:

1. On the CRO set the VIDEO CAL control to 1.0 and the 240-V-H control to the V or vertical position.

2. On the CRO Monitor Switcher, mounted just below the CRO, there are two rows of pushbuttons; one set for the CRO, one set for the Picture Monitor. To check DA #1, press the pushbutton VIDEO INPUT and for DA #2, press DEMOD OUT, in the CRO set of pushbuttons.

3. Adjust the VIDEO GAIN control knob on each amplifier until the input signal measures 1.0 volts peak-to-peak signal amplitude as indicated on the CRO scope. Refer to figure DA-2.

4. If sync and video signals are being mixed in DA #1 (304) adjust the SYNC GAIN control. Set the CRO and adjust the SYNC GAIN control until the amplitude of the sync is the required 0.4 volt portion of the composite signal as shown on the CRO.

5. The quality of the picture may be viewed on the Picture Monitor. Press the Monitor pushbuttons VIDEO INPUT and DEMOD OUT on the CRO Monitor Switcher.

MAINTENANCE

Keep the unit clean and free from dust. Periodically inspect resistors and capacitors for signs of discoloration caused by overheating. Check connecting cables and their connectors for cleanliness and tightness. Maintain a routine schedule for checking tubes in a mutual conductance tube tester. Replace those which are below standard or are otherwise defective. Keeping a log of the readings taken for each tube will help to anticipate tube failure by comparison with prior readings.

Alignment Procedure

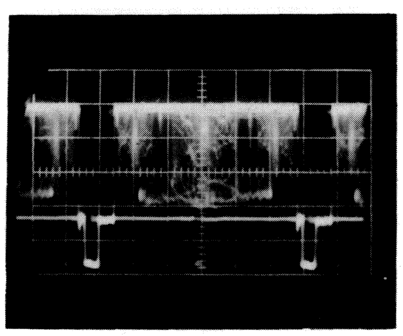
After changing any tube or after 1000 hours of operation, each distribution amplifier should be aligned. The System Recommended Test Equipment units, which are suitable, are as follows:

Video Transmission Test Signal Generator, Model 1003-C
Video Sweep Generator Type TLC1105 (0–10 MC)
Tetronics Oscilloscope Type 535

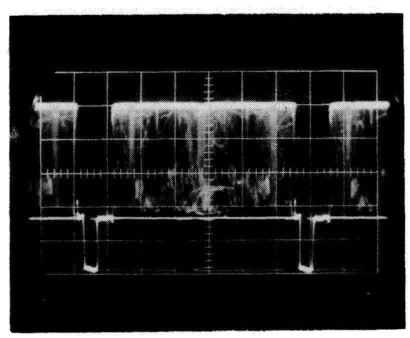
Before making any adjustments allow at least a five-minute warm-up period; then proceed as follows:

1. Remove the sync input cable, if used, and turn the SYNC GAIN control R46 fully counterclockwise.

2. Disconnect the cables J1 and J2 VIDEO INPUT; then connect the video sweep generator to the input, setting it to sweep from zero to 10 mc. Adjust the output for no more than 0.25 volt, peak-to-peak.



A. 1 v/cm, horizontal sweep rate.



B. 1 v/cm, horizontal sweep rate.

Figure DA-2. Waveforms of DA #1 and DA #2 Outputs

Do not exceed this value; decreased degeneration at the higher frequencies causes overloading at these frequencies. The resulting amplitude distortion would produce a false frequency-response indication.

3. With the oscilloscope adjusted for 60-cycle sine-wave horizontal deflection, measure the amplitude of the input signal at test jack J9. Move the oscilloscope probe to test J15. Adjust VIDEO GAIN control, R16, to set the amplitude of the signal to the same value that was measured at J9. Carefully adjust C5 and C22 alternately until the widest frequency response, consistent with the most uniform response, is displayed by the oscilloscope.

4. To test the output signals, proceed as follows:

a. For DA #1, insert the test probe into the input of the Modulator, unit 102, VID IN J2.

b. For DA #2, insert the test probe into the input of the Signal Processing Amplifier, unit 308, VIDEO IN, J17.

c. For each test, adjust C13 and C25 in the same manner as C5 and C22 in step 3, again checking for optimum frequency response in terms of bandwidth and uniformity. The amplitude of the signals at the output should be nearly equal to the input.

5. Reconnect the input signals and reset the output levels as outlined under SETUP FOR OPERATION.

Final gain adjustments should be made when the unit is mounted in its rack and normal video signals are applied.

Trouble Shooting

In case of abnormal operation, check the input jacks for the presence of normal signals. Check the power sources for normal voltages. Check the power connectors J8 and P8 for cleanliness and good contact. Be sure that all connecting cables are in perfect order and that their connectors are clean and tight. Check all tubes either in a mutual conductance tube tester or by substituting tubes known to be good.

The test jacks, conveniently located on the front of the chassis, make it easy to localize the fault to a particular section or component. Refer to the chart for the use of each test jack as well as the location and purpose of all jacks on the distribution amplifier chassis.

When the fault has been localized to a particular section or stage, the *Typical Operating Voltage Chart* is helpful in tracing the defective component. It is recommended that trouble shooting within the chassis be done by voltage analysis rather than by waveform analysis, because of the complexity of feedback loops. Removing the chassis from the mounting rack simplifies the making of repairs.

VIDEO DISTRIBUTION AMPLIFIER CONNECTOR CHART

Symbol Designation	*Chassis Location*	*Description*	*Function*
Inputs and Outputs			
J1	Rear	Coaxial (Fem.)	Blanked or composite input video signal.
J2	Rear	Coaxial (Fem.)	Blanked or composite input video signal.
J3	Rear	Coaxial (Fem.)	Sync input signal.
J4	Rear	Coaxial (Fem.)	Sync input signal.
J5	Rear	Coaxial (Fem.)	Output signal.
J6	Rear	Coaxial (Fem.)	Output signal.
J7	Rear	Coaxial (Fem.)	Output signal.
J8	Rear	Coaxial (Fem.)	6 contacts; AC Line and 280 v DC inputs; relay K1 connected to pins 9 and 11 (when used).
Test Points			
J9	Front	Red jack	To check presence of picture signal at input.
J10	Front	Blue jack	Marked SYNC: to detect presence of sync signal at input.
J11	Front	Green jack	Marked VIDEO: to detect presence or absence of video signal (or sync when used) at input to second amplifier section.
J12	Front	Red jack	To measure output signal at J5.
J13	Front	Red jack	To measure output signal at J6.
J14	Front	Red jack	To measure output signal at J7.
J15	Rear	Light green jack	To measure amplitude of input signal with VIDEO GAIN control R16 adjusted to set the amplitude of the signal to the same value as measured at J9.

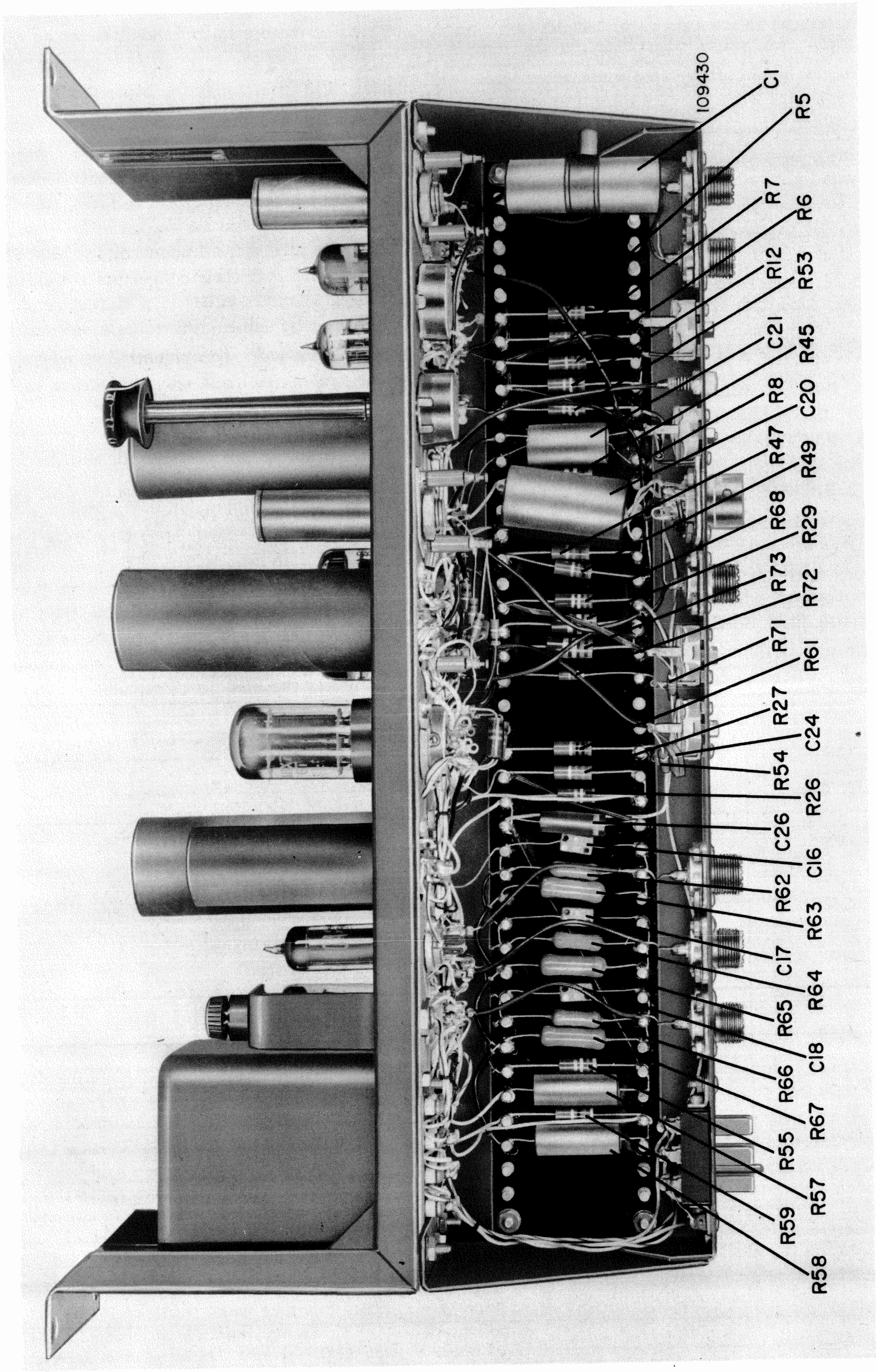


Figure DA-3. Internal View of Video Distribution Amplifier

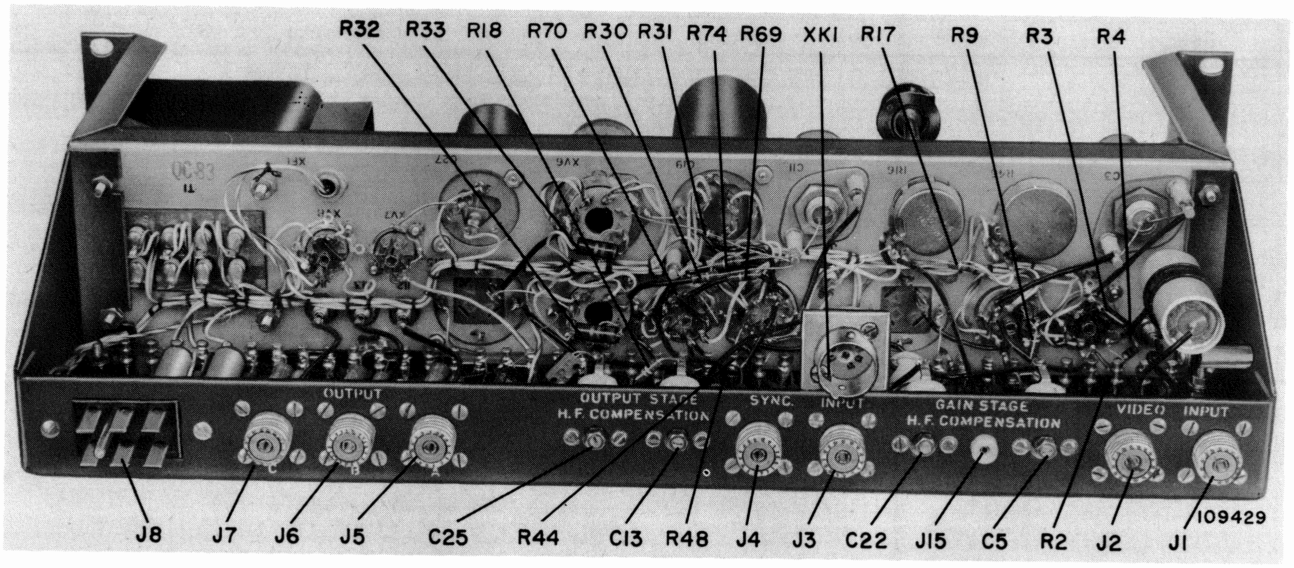


Figure DA-4. Rear View of Video Distribution Amplifier

TYPICAL OPERATION VOLTAGES

Tube	Pin								
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1A	138*	0	1.2						
V1B						280	138	139.5	
V2A	280	136.5	142						
V2B						0	−5.3		136.5
V3A	150 **12.8 AC	**4.0 AC	1.7 **1.8 AC					46.5	
V3B						280	200	2.35 AC	
V4A	138	−.5 1.15 AC	.84 1.05 AC						
V4B						280	136.5	138	
V5A	−10 2.4 AC	158 6.2 AC	0						
V5B				158 6.2 AC	280	164 3.15 AC			
V6A	−10 2.4 AC	158 6.2 AC	0						
V6B				158 6.2 AC	280	164 3.15 AC			
V7	0	−111							
V8						193	−85 ***245 AC RMS		

* All voltages DC except as indicated and measured with no signal applied.
** EIA sync; 4V peak-to-peak at sync input; sync gain control set at maximum.
*** 60 cycle sine wave; all other AC voltages are peak-to-peak and measured with 1.0-volt EIA blanking signal.

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
VIDEO DISTRIBUTION AMPLIFIER (#8829862-506)			
			CAPACITORS:
C1	99448	737818-417	paper, 1 μf ±10%, 400 v
C2			Not Used
C3	210342	8814169-3	paper, 1 μf ±10%, 400 v
C4			Not Used
C5	99446	258851-5	variable, ceramic, 8-50 $\mu\mu$f
C6, C7			Not Used
C8	99340	458558-7	electrolytic, 250 μf 300 v
C9, C10			Not Used
C11	210342	8814169-3	paper, 1 μf ±10%, 400 v
C12			Not Used
C13	99446	258851-5	variable, ceramic, 8-50 $\mu\mu$f
C14			Not Used
C15	99340	458558-7	electrolytic, 250 μf 300 v
C16 to C18		748252-321	mica, 39 $\mu\mu$f ±5%, 500 v char "C"
C19A/C	99345	458558-12	electroltyic, 40/40/40 μf 450 v
C20	99447	449633-50	electrolytic, 20 μf 350 v
C21	214250	737818-415	paper, 0.22 μf ±10%, 400 v
C22	54937	258851-3	variable, ceramic, 10-100 $\mu\mu$f
C23			Not Used
C24		748252-321	mica, 39 $\mu\mu$f ±5%, 500 v char "C"
C25	54937	258851-3	variable, ceramic, 10-100 $\mu\mu$f
C26		735715-163	paper, 0.01 μf ±10%, 400 v
C27A, B	34889	95695-39	electrolytic, 20/20 μf 450 v
F1	218628	990157-107	Fuse: 3/4 A 125 v
J1 to J7	51800	255223-2	Connector: coax
J8	99449	427017-6	Connector: male, 6 contact
J9	54409	845648-2	Connector: tip jack, red
J10	99215	845648-4	Connector: tip jack, blue
J11	99214	845648-3	Connector: tip jack, green
J12 to J14	54409	845648-2	Connector: tip jack, red
J15	99442	8825493-9	Connector: tip jack, light green
P1			Connector: coax
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - only, solder type
P2, P3	210715	8909771-501	Connector: male, coax termination
P4			Not Used
P5, P6			Connector: coax
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - only, solder type
P7	210715	8909771-501	Connector: male, coax termination
P8	99450	427017-5	Connector: female, 6 contacts
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1			Not Used
R2		82283-102	2.2 meg ±10%, ½ w
R3		82283-139	150 ohms, ±5%, ½ w
R4		82283-143	220 ohms, ±5%, ½ w
R5		90496-54	220 ohms, ±10%, 1 w
R6		90496-177	5600 ohms, ±5%, 1 w
R7		90496-231	1 meg ±5%, 1 w
R8		82283-146	300 ohms, ±5%, ½ w
R9		82283-149	390 ohms, ±5%, ½ w
R10, R11			Not Used
R12		90496-207	100,000 ohms, ±5%, 1 w
R13 to R15			Not Used
R16	218370	8971860-405	variable, 500 ohms, ±10%, 2 w
R17		82283-50	100 ohms, ±10%, ½ w
R18		82283-135	100 ohms, ±5%, ½ w
R19 to R25			Not Used
R26		90496-204	75,000 ohms, ±5%, 1 w
R27		90496-73	8200 ohms, ±10%, 1 w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R28			Not Used
R29		99126-78	22,000 ohms, ±10%, 2 w
R30,R31		82283-50	100 ohms, ±10%, ½ w
R32,R33		90496-142	200 ohms, ±5%, 1 w
R34,to R43			Not Used
R44		82283-98	1 meg ±10%, ½ w
R45		99126-74	10,000 ohms, ±10%, 2 w
R46	99444	746009-27	variable, 5000 ohms, ±10%, 2 w
R47		90496-64	1500 ohms, ±10%, 1 w
R48		82283-54	220 ohms, ±10%, ½ w
R49		90496-62	1000 ohms, ±10%, 1 w
R50 to R52			Not Used
R53		90496-192	24,000 ohms, ±5%, 1 w
R54		82283-142	200 ohms, ±5%, ½ w
R55		90496-196	36,000 ohms, ±5%, 1 w
R56			Not Used
R57,R58	59941	458572-57	wire wound, 1800 ohms, ±5%, 5 w
R59		90496-46	47 ohms, ±10%, 1 w
R60			Not Used
R61		90496-38	10 ohms, ±10%, 1 w
R62	216799	990730-209	film, 121 ohms, ±1%, ½ w
R63	216800	990733-230	film, 200 ohms, ±1%, 1 w
R64	216799	990730-209	film, 121 ohms, ±1%, ½ w
R65	216800	990733-230	film, 200 ohms, ±1%, 1 w
R66	216799	990730-209	film, 121 ohms, ±1%, ½ w
R67	216800	990733-230	film, 200 ohms, ±1%, 1 w
R68		90496-91	270,000 ohms, ±10%, 1 w
R69		82283-50	100 ohms, ±10%, ½ w
R70		82283-135	100 ohms, ±5%, ½ w
R71		82283-91	270,000 ohms, ±10%, ½ w
R72		82283-57	390 ohms, ±10%, ½ w
R73		99126-78	22,000 ohms, ±10%, 2 w
R74		82283-98	1 meg ±10%, ½ w
T1	98399	949661-1	Transformer: power
XF1	48894	99088-2	Holder: fuse
XK1	94879	737867-18	Socket: relay
XV1 to XV4	94926	737870-14	Socket: tube, 9 pin
XV5,XV6	54414	99390-1	Socket: tube, octal
XV7,XV8	94925	737867-14	Socket: tube, 7 pin
			Miscellaneous:
	30075	712336-507	Knob

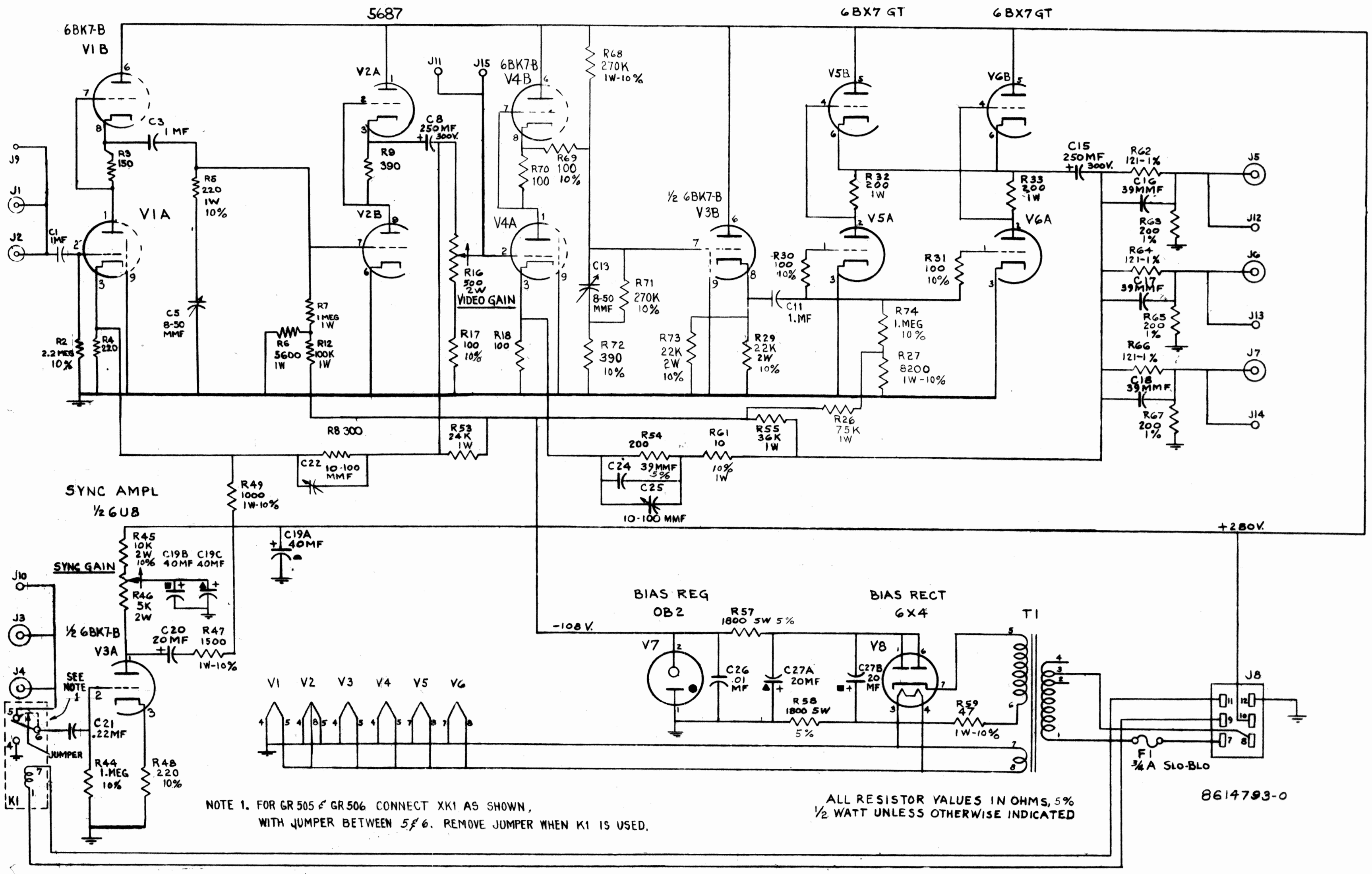


Figure DA-5. Schematic Diagram

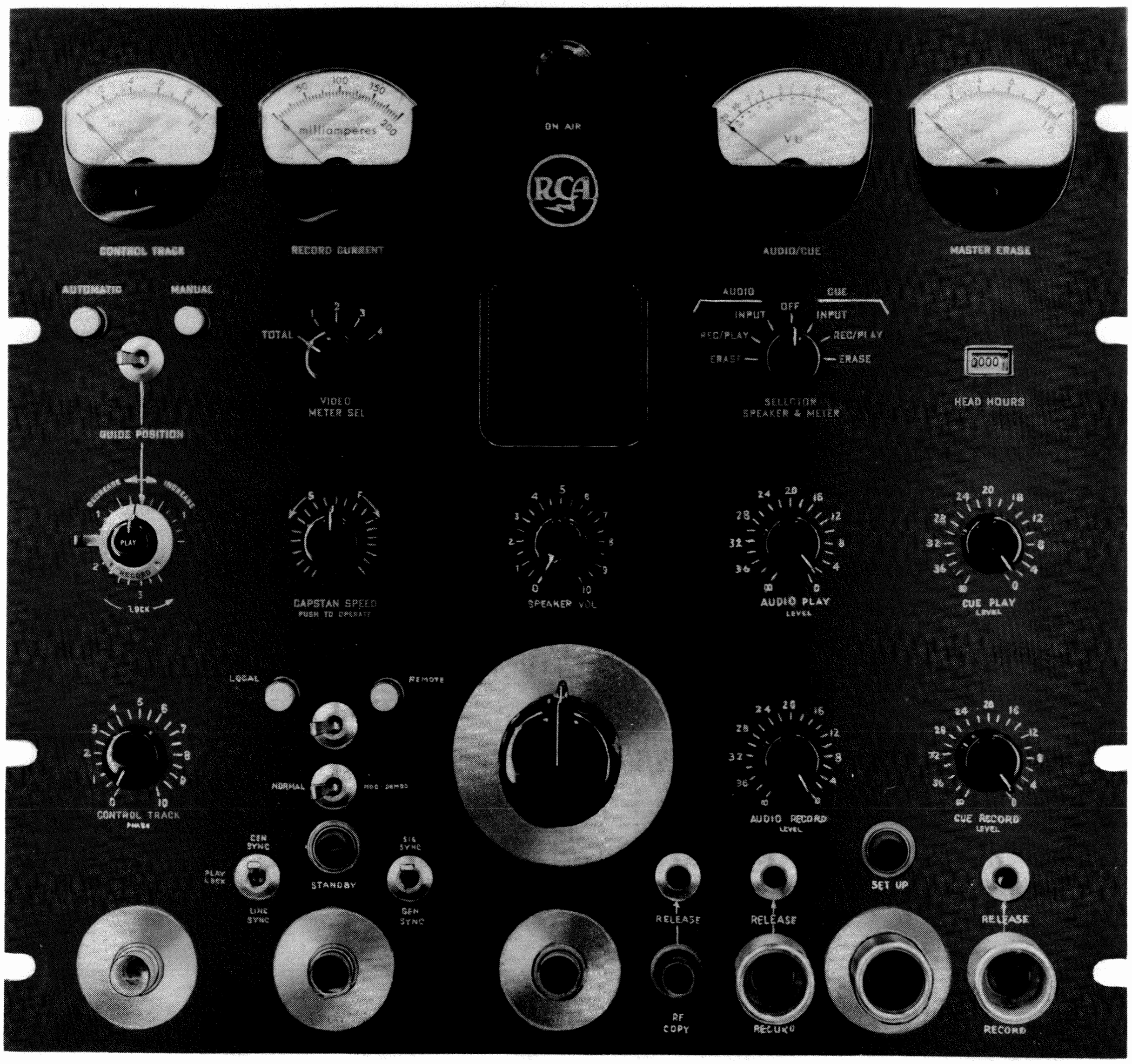
Control Panel and Control Relay Bank

UNIT 305

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 681

IB-31143



111975

Figure CP-1. Control Panel, Front View

TECHNICAL DATA

Power Supplied

AC: 117 volts, 50/60 cycles*, 5.5 amperes maximum (in record mode), from circuit breaker no. 2.

DC: 24 volts, 7.6 amperes maximum, from 24 volt dc power supply (unit 507).

Audio and Cue Input Levels

Audio line in: —10 to +4 VU into 600 ohm balanced line matching input.

Cue line in: —10 to +4 VU into 600 ohm balanced line matching input.

Audio and Cue Output Levels

Audio line out: +8 VU into 600 ohm balanced line.

Cue line out: 0 VU into 600 ohm balanced line.

Lamps

4 — GE type 327 or equivalent.
9 — Sylvania type 30B or equivalent.
1 — GE type 356 or equivalent.

Diodes

5 — 1N2069.

Contact Protectors

33 — International Rectifier S2V1P or equivalent.
4 — International Rectifier S5V5P or equivalent.

Fuses

5 amp, slo-blo, 3AG (in 117 volt ac line).
2 amp, 3AG (in 24 volt dc line).

* The only alteration required for 50 cycle operation of the control panel and control relay bank is the replacement of the head hour meter by one which operates on 50 cycle voltage. This replacement is made at the factory on units designated for shipment outside the U.S.A.

PART I. CONTROL PANEL

DESCRIPTION

All controls required to operate the tape recorder are centralized at the master control panel, unit 305 (figure CP-1). Five meters, a small speaker, and indicator lights are also provided on the control panel for use in monitoring or setting up various parameters essential to optimum operation of the tape recorder. The function of each control and indicator is described in the *Control and Indicator Functional Chart.* The operation of relays associated with each control is described in Part II *(Control Relay Bank).*

NOTE: When operation of the tape recorder from a remote location is desired, a remote control panel (MI-40716B or MI-40716D), which permits handling of all basic tape recorder functions, is available. (For a detailed description of the remote control panel, refer to IB-31106-1).

All pushbuttons on the control panel, with the exception of the release pushbuttons, are illuminated when pressed. The lamp behind the RF COPY pushbutton flashes on and off when this pushbutton is pressed as an indication that the machine is not in a normal mode. The pushbutton controls are interlocked so that opposing modes cannot be entered simultaneously. Guards protect the RECORD, AUDIO RECORD, and CUE RECORD pushbuttons against being accidentally pressed while the machine is operating in another mode.

The *Local Mode Switching* chart indicates the various operating modes of the machine which may be obtained at the local and remote control panels. The chart also shows which modes may be entered from each individual operating mode.

LOCAL MODE SWITCHING†

Mode	*May be Switched to*								
	STOP	*WIND*	*Master RECORD*	*AUDIO RECORD*	*CUE RECORD*	*PLAY*	*SETUP*	*STANDBY*	*RF COPY*
STOP	—	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
WIND	Yes	—	No	No	No	No	No	No	No
Master RECORD	Yes	Yes	—	*	*	Yes	No	No	Yes
AUDIO RECORD	Yes	Yes	**	—	**	Yes***	No	No	Yes
CUE RECORD	Yes	Yes	**	**	—	Yes***	No	No	Yes
PLAY	Yes	Yes	Yes	Yes	Yes	—	No	No	Yes
SETUP	Yes	Yes	Yes	Yes	Yes	Yes	—	Yes	Yes
STANDBY	Yes	Yes	No	Yes	Yes	Yes	No	—	Yes
RF COPY	Yes	Yes	Yes**	Yes**	Yes**	Yes**	Yes**	No	—

† Remote mode switching is identical to local mode switching with the wind mode replaced by fast forward and fast reverse modes. In remote mode switching it is also possible to switch from fast forward to fast reverse mode and vice versa. There is no provision for placing the machine in standby mode from the remote control panel. However, the machine may be placed in standby from the local control panel, in which case any remote control pushbutton except RECORD will supersede.

* Audio record and cue record are always on when machine is in master record mode.

** Second mode comes on without dropout of first mode.

*** Audio record and cue record may be released separately, except when the machine is in master record mode. If audio or cue is on alone, and then released, the machine goes into the playback mode. If audio and cue are on simultaneously, releasing one leaves the machine in the other mode; releasing both places the machine in the playback mode.

CONTROL AND INDICATOR FUNCTIONAL CHART

Control Panel Designation	*Type of Control or Indicator*	*Function of Control or Indicator*
ON AIR	24 volt dc lamp (glows red).	When lit, indicates program is being transmitted. NOTE: This indicator requires an external connection to jack J28 (ON AIR) which is located on the connector strip of the control relay bank (figure CP-4).
STOP	Pushbutton.	Instantaneously releases the machine from any mode of operation at any time.
PLAY	Pushbutton.	Places the machine in the playback mode. (The playback mode may be entered from any mode except wind.)
RECORD	Pushbutton.	Places the machine in the record mode. Audio and cue modes are automatically entered when the RECORD pushbutton is pressed. (The record mode may be entered from any mode except standby and wind.)
AUDIO RECORD	Pushbutton.	Allows audio information to be recorded when machine is in video playback mode. (The audio record mode is automatically entered when the machine is placed in the record mode.)
RELEASE (Audio)	Pushbutton.	Places the machine in the playback mode if pressed while the AUDIO RECORD pushbutton is depressed. Exception: the RELEASE pushbutton is ineffective if pressed when machine is in the record mode. Also, refer to *NOTE* under CUE RECORD.
CUE RECORD	Pushbutton.	Allows cue information to be recorded when machine is in playback mode. (The cue record mode is automatically entered when the machine is placed in the record mode.) NOTE: Both audio and cue record modes may be entered simultaneously. When both modes are in use, releasing either mode will leave the machine in the remaining mode.
RELEASE (Cue)	Pushbutton.	Places the machine in the playback mode if pressed while the CUE RECORD pushbutton is depressed. Exception: the RELEASE pushbutton is ineffective if pressed when machine is in the record mode. Also, refer to *NOTE* under CUE RECORD.
SET UP	Pushbutton.	Places machine in the record mode while preventing tape motion, and keeps headwheel from contact with the tape. (The setup mode may be entered from stop or rf copy modes only.)
STANDBY	Pushbutton.	Places machine in the playback mode while preventing tape motion, and keeps headwheel from contact with the tape. (The standby modes may be entered from stop or setup modes only.)
RF COPY	Pushbutton.	Places machine in rf copy mode while preventing tape motion.

CONTROL AND INDICATOR FUNCTIONAL CHART (Continued)

Control Panel Designation	*Type of Control or Indicator*	*Function of Control or Indicator*
RELEASE (RF Copy)	Pushbutton.	Places machine in the companion mode when pressed; e.g., when RF COPY and PLAY pushbuttons are depressed, pressing the RELEASE pushbutton will place the machine in the playback mode only.
WIND	Pushbutton.	Delegates control of the upper and lower reel motors, located on the tape transport panel (unit 200), to the variable FORWARD/REVERSE control. (The wind mode may be entered from any other mode; however, it is not possible to enter another mode from the wind mode without first pressing the STOP pushbutton.)
FORWARD/REVERSE	Variable transformer.	Allows manual control of the tape wind speed, in forward or reverse direction, when the WIND pushbutton is depressed.
CONTROL TRACK PHASE	Potentiometer.	Adjusts capstan phasing so that the video heads are properly centered over the recorded video tracks during playback.
LOCAL/REMOTE	Two-position toggle switch; two 24 volt dc lamps (tally lights).	Control of the various modes of operation of the machine is delegated to the remote control panel when the switch is placed in REMOTE position. Control of the various modes is retained by the master control panel when the switch is placed in LOCAL position. The switch position is indicated by the illumination of one of the two tally lights.
GUIDE POSITION	Two-position toggle switch; two 24 volt dc lamps (tally lights).	Switch determines whether the vacuum guide will be controlled automatically (AUTOMATIC position), or manually (MANUAL position) by the GUIDE POSITION PLAY knob. The switch position is indicated by the illumination of one of the two tally lights. (The AUTOMATIC position of the switch is operative only in the playback mode.)
	Dual, concentric potentiometer.	RECORD knob (outer knob) permits manual adjustment of the vacuum guide position when the machine is in the record mode. Once set, the knob may be secured by the rotating locking-lever. PLAY knob permits adjustment of the vacuum guide position when the machine is in the playback mode, and is independent of the RECORD knob setting.
CAPSTAN SPEED	Potentiometer, combined with momentary pushbutton switch.	Permits control of the capstan speed when pressed in and rotated. (Operative in the playback mode only.)
CONTROL TRACK	Meter.	Monitors control track head current.
NORMAL/MOD-DEMOD	Two-position toggle switch.	MOD-DEMOD position energizes modulator and demodulator relays so that a picture may be obtained on the picture monitor through the modulator-demodulator without tape motion and without energizing the headwheel motor or capstan motor.

CONTROL AND INDICATOR FUNCTIONAL CHART (Continued)

Control Panel Designation	*Type of Control or Indicator*	*Function of Control or Indicator*
PLAY LOCK GEN SYNC/LINE SYNC	Two-position toggle switch.	Switch permits locking the system to local sync (GEN SYNC) or the 60 cycle line (LINE SYNC), when the machine is in the playback mode.
REC LOCK SIG SYNC/GEN SYNC	Two-position toggle switch.	Switch permits locking the system to separated sync from the 2 x 1 switcher (SIG SYNC) or to local sync (GEN SYNC), when the machine is in the record mode.
VIDEO METER SEL	Five position wafer switch.	Selects an individual video head current (1, 2, 3, 4), or the total video head current (TOTAL), to be monitored by the RECORD CURRENT meter during the record mode of operation.
RECORD CURRENT	Meter.	Indicates the current value of the video head which has been selected by the VIDEO METER SEL switch during the record mode of operation.
SPEAKER VOL	Dual potentiometer.	Controls the output level of the monitor speaker.
SELECTOR SPEAKER & METER	Seven position wafer switch.	Selects AUDIO or CUE information to be monitored by the AUDIO/CUE meter and speaker as follows: INPUT: Program input level. REC/PLAY: Recording level when the machine is in the record mode; output level when machine is in the playback mode. ERASE: Audio or cue erase head current (in record or setup modes only) on AUDIO/CUE meter. Speaker remains in REC/PLAY mode.
AUDIO/CUE	ASA VU meter.	Indicates AUDIO or CUE information selected by the SELECTOR SPEAKER & METER switch.
AUDIO PLAY LEVEL	Attenuator.	Varies the audio output level during playback or simultaneous playback as indicated on the AUDIO/CUE meter with SELECTOR switch in AUDIO REC/PLAY position. (Does not affect the monitor level.)
AUDIO RECORD LEVEL	Attenuator.	Varies the speaker output level, and also the level of the audio signal to the audio record head as indicated on the AUDIO/CUE meter with SELECTOR switch in AUDIO REC/PLAY position.
CUE PLAY LEVEL	Attenuator.	Varies the cue level during playback mode as indicated on the AUDIO/CUE meter with SELECTOR switch in CUE REC/PLAY position.
CUE RECORD LEVEL	Attenuator.	Varies the speaker output level, and also the level of the cue signal to the cue record head as indicated on the AUDIO/CUE meter with SELECTOR switch in the CUE REC/PLAY position.
MASTER ERASE	Meter.	Indicates the voltage developed across the erase head.
HEAD HOURS	Elapsed time meter.	Continuously records the time, in hours, during which the video heads are in use (playback or record modes).

PART II. CONTROL RELAY BANK

DESCRIPTION

Most of the relays which are activated by the control panel pushbuttons and switches are mounted on the control relay bank chassis and the auxiliary relay bank. The control relay bank chassis (figures CP-3 and CP-4) is located behind the control panel and is hinged so that it may be swung outward away from the rack, providing easy access to the inner side of the relay bank chassis, the rear of the control panel, and the auxiliary relay bank (mounted on the left-hand side of the rack, between the control panel and the control relay bank, as shown in figure CP-5). Removable covers are provided on both sides of the control relay bank chassis to protect the relays from dust and dirt.

Connections from the control panel to the control relay bank are made through jacks J35 and J36 on the relay bank chassis (figure CP-3). Cable connector plugs and jacks are mounted in two rows beneath the relay bank assembly (the bottom row is actually mounted on the control panel chassis), to accommodate external connections to the control panel and relay bank. Mounted along the left-hand edge of the rear of the relay bank chassis are the 117 volt ac and 24 volt dc receptacles (J32 and J33), two fuses (one in each voltage line), the remote control panel cable receptacle (J34), and adjustable resistors R11 and R12 (which are used in varying the upper and lower tape reel motor voltages as described in the section on *Maintenance*).

Relays K35, K36, K37, and K38 have adjustable time-delays which have been set to nominal values at the factory (see *Time Delay Relay Chart*), but which may be adjusted for longer or shorter delays if desired. An Amperite Type 26F90T flasher (S29) is also mounted on the relay bank chassis (figure CP-3), the purpose of which is to cause the lamp behind the RF COPY pushbutton to flash on and off when this pushbutton is pressed.

Components mounted on the auxiliary relay bank (figure CP-5) consist of transformer T2, time-delay relay K38, plug-in relay K39, and jack J41. All connections to the auxiliary relay bank are made through jack J41.

Circuits

The operation of the various relay circuits may be best understood by referring to the relay ladder diagrams and accompanying *Relay Functional Chart* which follow the section on *Maintenance*. However, the operation of the air pump timer circuit is described here because of the time-delay circuits involved:

When power is applied to the machine, relay K18 remains deenergized allowing the air pump to operate. (The air pump relay is energized when contacts 7 and 8 of K18 are closed, as shown on the schematic diagram, figure CP-13.) Simultaneously, relays K35 and K36 are energized through the closed contacts of relays K34 and K18. After 5 seconds relay K35 operates, thus energizing the air valve, which in turn cuts off air to the air guides. After 40 seconds relay K36 operates, thus energizing relay K18. When K18 is energized it locks itself on through other relay contacts. At the same time ac voltage is cut off relays K35 and K36 and the air pump relay is deenergized, thus cutting off the air. As long as the machine is in the STOP mode, after the initial period, these relays remain in this condition. Stopping after any mode will recycle the pump and relay operation as described. Going to any mode from STOP immediately turns on the air pump and opens up the air guide valve cutoff.

The *Control Chart for Individual Units (Condition of Relays, Solenoids, or Motors During Each Operating mode)* indicates the condition of relays, solenoids, or motors of individual units during the various tape recorder modes of operation.

TIME DELAY RELAY CHART

Relay No.	*Relay Designation*	*Time* Delay*	*Purpose of Time Delay*
K35	Air Valve Timer	5	To prevent the air valve from cutting off the air to the air guides for 5 seconds after the STOP pushbutton is pressed, thereby allowing for tape "coasting time" when switching from FAST FORWARD or FAST REVERSE modes to STOP mode.
K36	Air Pump Timer	40	To cut off the air pump 40 seconds after the STOP pushbutton has been pressed.
K37	Guide Timer	1	To hold vacuum guide off the tape until headwheel has had time to lock-in.
K38 (on auxiliary relay bank)	Lower Reel Time Delay	2	To allow the lower tape reel motor sufficient time to develop the torque required to overcome the inertia of a heavily loaded tape reel.

* Time delay in seconds (nominal).

CONTROL CHART FOR INDIVIDUAL UNITS (CONDITION OF RELAYS, SOLENOIDS, OR MOTORS DURING EACH OPERATING MODE)

	OPERATING MODES										
	Master RECORD	PLAY	WIND	AUDIO RECORD	CUE RECORD	SETUP	STANDBY	RF COPY*	STOP	MOD-DEMOD **	NOTES
MODULATOR											
K1	E	D	D	D	D	E	D	D	D	E	
RECORD AMPLIFIER											
K1	E	D	D	D	D	E	D	E	D	D	
VIDEO PREAMPLIFIER											
K1	E	D	D	D	D	E	D	E	D	D	
TAPE TRANSPORT PANEL											
Reel Brake Solenoid	E	E	E	E	E	D[1]	D[1]	D[1]	D[1]	D[1]	[1]Overridden by foot switch.
Capstan Roller Solenoid	E	E	D	E	E	D	D	D	D	D	
Guide Solenoid (1 sec. delay, approximately)	E	E	D	E	E	D	D	D	D	D	
Reel Motors	E	E	E	E	E	D	D	D	D	D	
DEMODULATOR											
K1	E	D	D	D	D	E	D	E	D	E	
K2	E	D	D	D	D	E	D	D	D	D	
K3	D	D	D	D	D	D	D	D	D	D	
AUDIO PANEL											
K1, K2, K3	E[2]	D	D	E	D	E[2]	D	D	D	D	[2]Relays K1 and K4 (muting relays) are energized momentarily when going to or from a record mode.
K4, K5, K6	E[2]	D	D	D	E	E[2]	D	D	D	D	
HEADWHEEL BLOWER MOTOR	E	E	E	E	E	E	E	E	D	D	
CONTROL PANEL											
Head Hour Meter	E	E	D	E	E	D	D	D	D	D	
Guide Position (K40)	E	D	D	D	D	E	D	D	D	D	
PROCESSING AMPLIFIER											
K1	D	D	D	D	D	D	D	D	D	D	Relay operates in color mode only.
2 X I SWITCHER											
K1	D	D	D	D	D	D	D	D	D	D	
CAPSTAN SERVO											
K1	E	D	D	D	D	E	D	D	D	D	
K2	E	D	D	D	D	E	D	D	D	D	
K3	D	D[3]	D	D	D	D	D	D	D	D	[3]Energized by depressing CAPSTAN SPEED knob on control panel.
K5	E	D	D	D	D	E	D	D	D	D	
K6	E	E	E	E	E	E	E	E	D	D	
REFERENCE GENERATOR											
K1	E[4]	D	D	D	D	E[4]	D	D	D	D	[4]When using generator sync (GEN SYNC) relay is de-energized.
K2	D	D[5]	D	D	D	D	D[5]	D	D	D	[5]When using line sync (LINE SYNC) relay is energized.
HEADWHEEL SERVO											
K1	E	E	E	E	E	E	E	E	D	D	
GUIDE SERVO											
K1	D	E[6]	D	E[6]	E[6]	D	D	D	D	D	[6]Overridden by GUIDE POSITION switch on control panel (MANUAL position).
AIR PUMP	E	E	E	E	E	E	E	E	E[7]	D	[7]Shuts off after 40 second delay.
COLOR OPERATION											
PROCESSING AMPLIFIER											
K1	E	E	D	E	E	E	D	D	D	E	Interlocked by manual switches.
5K1	E	D	D	D	D	E	D	D	D	E	Interlocked by manual switches.
5K2	E	E	D	E	E	E	D	D	D	E	Dependent upon presence of burst.
CHROMA PROCESSOR											
K1	E	E	D	E	E	E	E	D	D	E	Interlocked by manual switches.

CODES: E - Energized.
D - De-energized.

* RF Copy mode only. Any combination of the RF Copy mode with another mode will modify the relay conditions.

** May override Wind, Stop, or Standby modes as shown.

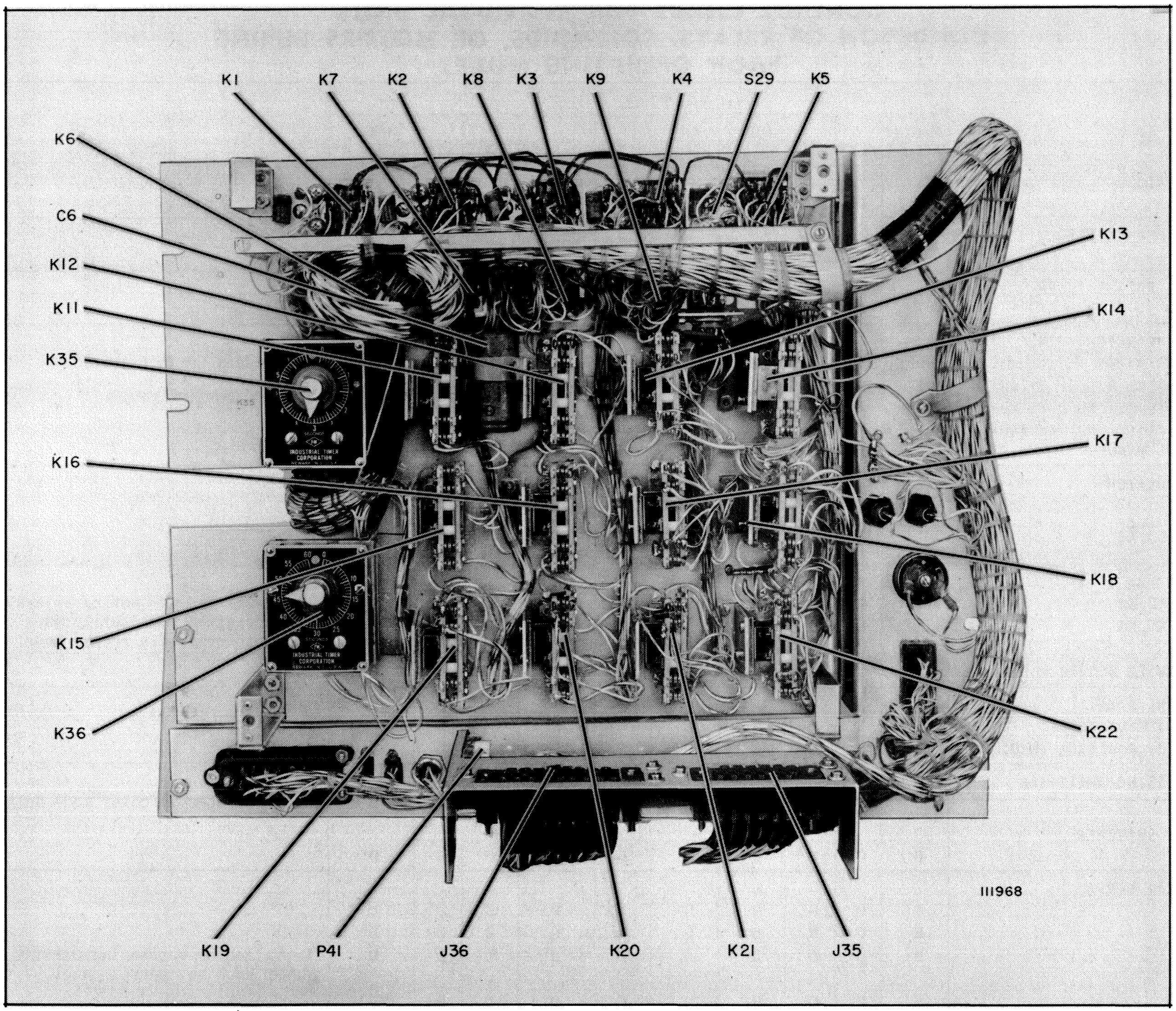


Figure CP-3. Control Relay Bank, Inner View (Cover Removed)

CONTROL RELAY BANK MAINTENANCE

General

Since the control relay bank components consist primarily of electro-mechanical devices, care must be taken to guard against loose connections and poor contacts. All connectors should be secured, and the covers which are fastened to the inner and outer sides of the control relay bank chassis should be kept in place so that the relays are protected against dust and dirt.

As previously noted, the control relay bank chassis is hinged so that it may be swung outward away from the rack after the removal of three thumb-screws along the right-hand edge. This facilitates component checking or replacement on the inner side of the relay bank chassis, and also provides access to the auxiliary relay bank and the rear of the control panel.

24 Volt DC Relay Voltage

The 24 volt dc power supplied to the control relay bank is connected with the positive side grounded at the power supply. (This is the only ground connection in the control circuitry.) Most of the relay switching occurs on the ground side, so that an accidental short circuit will in all probability cause a relay to operate, thus preventing the power supply from drawing excessive current. The negative side of the power supply can be connected to ground instead of the positive side; however, in this case a short circuit will cause the relay wiring to become overheated. Electrolytic capacitors used in the control relay bank are not affected by reversing the ground connection.

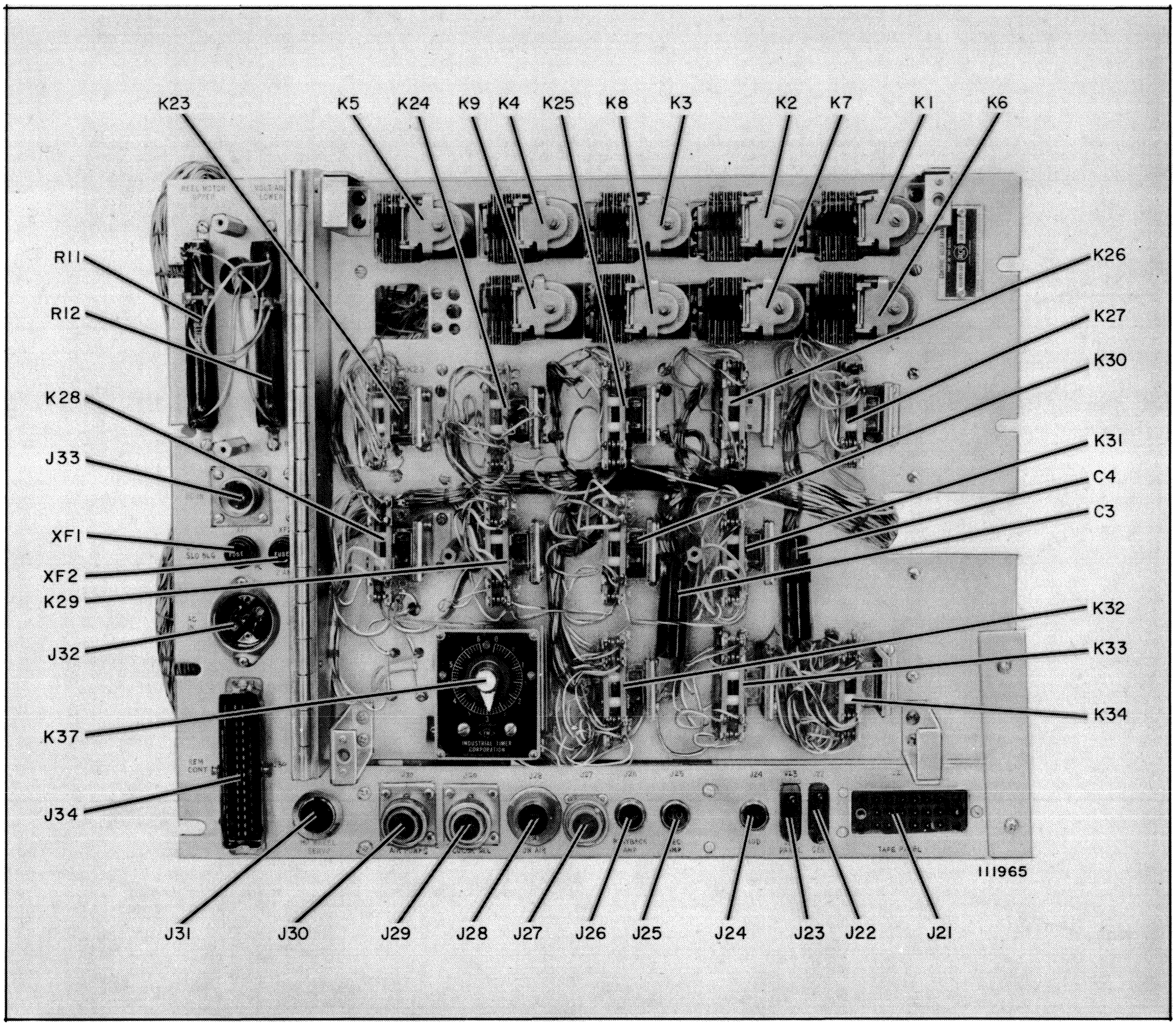


Figure CP-4. Control Relay Bank, Outer View (Cover Removed)

Tape Reel Motor Voltage Adjustments

With the machine in playback mode, place empty tape reels on the upper and lower tape reel hubs and adjust upper and lower tape reel motor voltages, utilizing adjustable resistors R11 and R12, as follows:

Upper Reel Motor. (With the machine in playback mode the upper reel motor will run in a clockwise direction.)

1. Wrap a short length of old tape around the hub of the empty reel and attach a spring-scale to the loose end.

2. Adjust resistor R11 until the motor produces 10 ounces of pull as measured on the spring scale.

3. Measure the voltage across terminals 2 and 3 of terminal board TB1 (at the rear of the reel motor). The voltage should be approximately 45 volts ac.

Lower Reel Motor. (With the machine in playback mode the lower reel motor will run in a counterclockwise direction).

1. Wrap a short length of old tape around the hub of the empty reel and attach a spring-scale to the loose end.

2. Adjust resistor R12 until the motor produces 20 ounces of pull as measured on the spring-scale.

3. Measure the voltage across terminals 2 and 3 of terminal board TB2 (at the rear of the reel motor). The voltage should be approximately 65 volts ac.

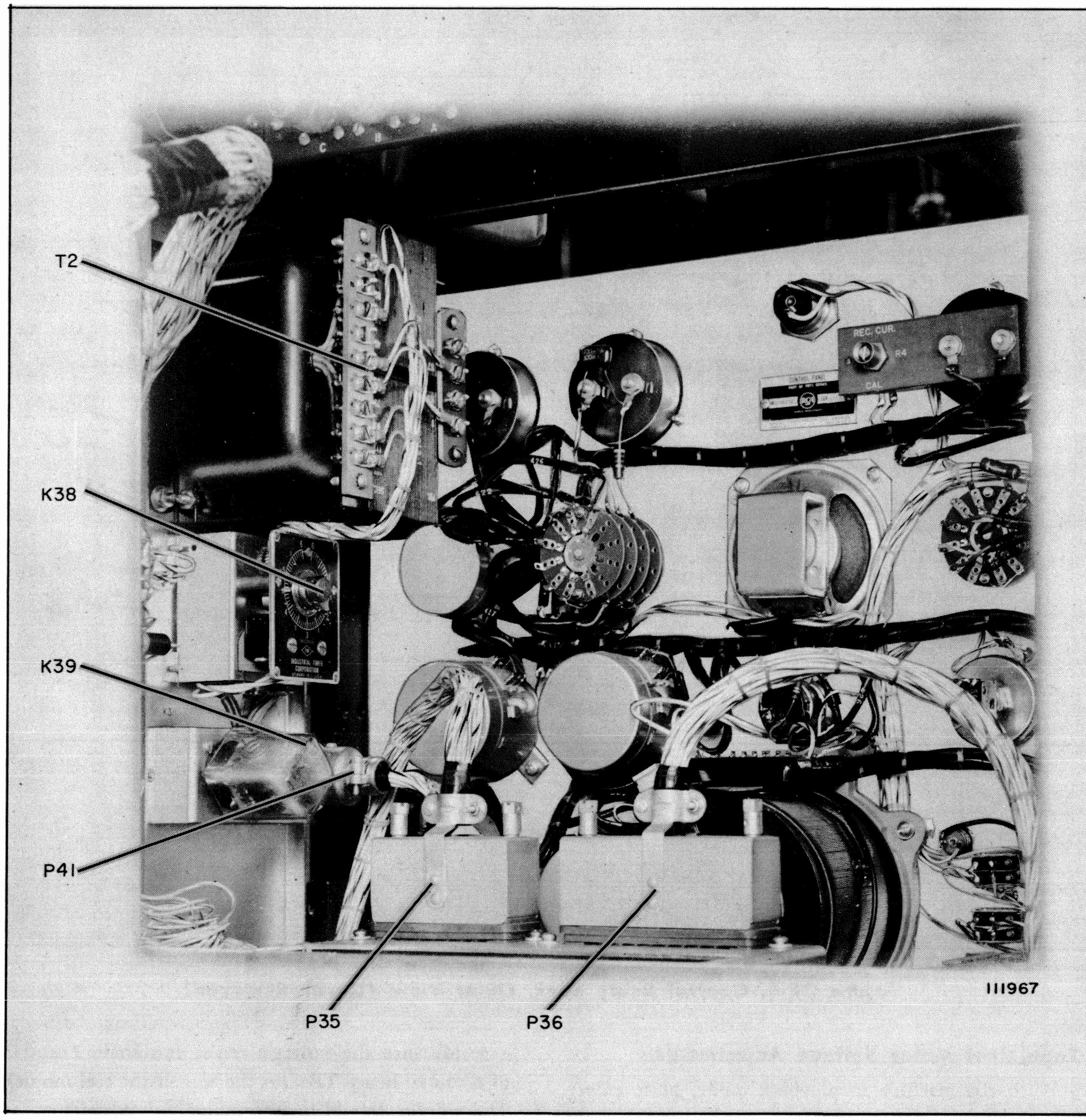


Figure CP-5. Auxiliary Relay Bank

Relay Maintenance

Relays or relay contacts should not be cleaned or disturbed unless evidence of improper relay operation exists. If it becomes necessary to clean the relay contacts, a good grade of cardboard (such as that used for calling cards) should be used to burnish the contacts. In cases of severe pitting a burnishing tool may be used to clean the relay contacts, or, if the burnishing tool is not available, a fine grade of crocus cloth may be used.

The *Relay Functional Chart* and relay ladder diagrams are presented as an aid in understanding the operation of the various relays as well as a guide to trouble-shooting the control relay bank.

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
CONTROL RELAY BANK (8511093-501) 8			
C1			Not Used
C2	78927	984655-10	Capacitor: electrolytic, 20 μf 50 v
C3, C4		8970812-1	Capacitor: paper, 0.22 μf 600 v
C5			Not Used
C6	221790	8958264-41	Capacitor: electrolytic, 500 μf 50 v
C7	218097	8976580-1	Capacitor: ceramic, 0.1 μf -20 +80%, 500 v
CR1 to CR9	219261	8981614-102	Diode: contact protector
CR10			Not Used
CR11 to CR19	219261	8981614-102	Diode: contact protector
CR20			Not Used
CR21 to CR34	219261	8981614-102	Diode: contact protector
CR35 to CR37	219260	8981614-5	Diode: contact protector
CR38			Not Used
CR39	219260	8981614-5	Diode: contact protector
CR40			Not Used
CR41 to CR43	218612		Diode: type 1N2069
CR44, CR45			Not Used
CR46	218612		Diode: type 1N2069
F1	94802	990157-113	Fuse: 5 amp 125 v slo-blo
F2	3883	990157-10	Fuse: 2 amp 250 v
J1 to J20			Not Used
J21	219314	474827-47	Connector: female, 18 contact
J22	219312	474827-36	Connector: female, 7 contact
J23	219313	474827-41	Connector: female, 11 contact
J24 to J26	43671	182271-1	Connector: female, 2 contact
J27	222652	8978091-21	Connector: female, 4 contact
J28	211510	481799-2	Connector: female, 2 contact
J29	219779	8978091-15	Connector: female, 5 contact
J30	219293	8978091-3	Connector: female, 6 contact
J31	95182	458540-5	Connector: female, 3 contact
J32	210267	8887007-1	Connector: male, 3 contact
J33	219316	8978091-7	Connector: male, 3 contact
J34	221792	8442587-2	Connector: male, 32 contact
J35	221791	474827-71	Connector: female, 24 contact
J36	219315	474827-48	Connector: female, 34 contact
J37 to J40			Not Used
J41	221795	8978092-3	Connector: male, 12 contact
K1 to K9	221860	8515279-1	Relay: 24 v D.C.
K10			Not Used
K11 to K34	221793	8448846-1	Relay: 24 v D.C.
K35	218274	8439074-1	Relay: timer, 115 v 60 cycle, max. delay 6 sec.
K36	221789	8439074-3	Relay: timer, 115 v 60 cycle, max. delay 1 min
K37	218274	8439074-1	Relay: timer, 115 v 60 cycle, max. delay 6 sec.
K38	218274	8439074-1	Relay: timer, 115 v 60 cycle, max. delay 6 sec.
K39	221799	460355-11	Relay: 115 v
P1 to P20			Not Used
P21	219303	474827-44	Connector: male, 18 contact
P22	219543	474827-57	Connector: male, 7 contact
P23	219542	474827-56	Connector: male, 11 contact
P24 to P26	43670	253979-5	Connector: male, 2 contact
P27	219534	8978091-5	Connector: male, 4 contact
P28	211509	481799-1	Connector: male, 2 contact
P29	220146	8978091-16	Connector: male, 5 contact
P30	219535	8978091-6	Connector: male, 6 contact
P31	95180	458540-1	Connector: male, 3 contact
P32	210467	8916577-1	Connector: female, 3 contact
P33	219548	8978091-8	Connector: female, 3 contact
P34	222416	8442587-1	Connector: female, 32 contact
P35 to P40			Not Used
P41	221794	8978092-2	Connector: female, 12 contact
R1 to R10			Not Used
R11, R12	52716	427491-47	Resistor: wire wound, 25 ohms, 50 w
R13		82283-46	Resistor: 47 ohms, ±10%, ½ w
S1 to S28			Not Used

Symbol No.	Stock No.	Drawing No.	Description
S29	218263	8978063-1	Switch
T1			Not Used
T2	221800	8460212-1	Transformer: isolation
XF1, XF2	48894	99088-2	Holder: fuse
XK1 to XK38			Not Used
XK39	68590	99100-4	Socket: relay
XS1 to XS28			Not Used
XS29	94926	737870-14	Socket: tube, 9 contact
CONTROL PANEL (8511463-501)			8
AT1 to AT4	218256	8439047-1	Attenuator: 600/600 ohms
C1 to C10			Not Used
C11		8924416-325	Capacitor: mica, 4700 μμf ±5%, 300 v char "F"
CR1 to CR39			Not Used
CR40	219261	8981614-102	Diode: contact protector
CR41 to CR44			Not Used
CR45	218612		Diode: type 1N2069
DS1, DS2	95439	145709-8	Lamp: indicator
DS3, DS4			Not Used
DS5 to DS9	95439	145709-8	Lamp: indicator
DS10			Not Used
DS11A/B	207238	8890654-2	Lamp: 28 v
DS12 to DS23			Not Used
DS24, DS25	95439	145709-8	Lamp: indicator
DS26, DS27			Not Used
DS28	51462	849546-14	Lamp: pilot, 24 v
DS29 to DS31			Not Used
DS32A/B	207238	8890654-2	Lamp: 28 v
J1	219304	474827-59	Connector: male, 9 contact
J2	219299	474827-33	Connector: female, 9 contact
J3	219300	474827-34	Connector: male, 11 contact
J4	213288	8720082-1	Connector: female, 3 contact
J5	219301	474827-35	Connector: male, 9 contact
J6	219308	8439039-2	Connector: female, 3 contact
J7	203821	458540-9	Connector: male, 3 contact
J8	219297	458540-20	Connector: male, 4 contact
J9	219298	474827-32	Connector: male, 7 contact
J10	219311	8978091-9	Connector: male, 3 contact
J11	219309	8720082-4	Connector: female, 4 contact
J12	219310	8720082-5	Connector: male, 4 contact
J13	219307	8439039-1	Connector: male, 3 contact
J14	219294	8720082-2	Connector: male, 3 contact
J15	219306	474827-63	Connector: male, 20 contact
J16	219302	474827-42	Connector: female, 14 contact
K1 ro K39			Not Used
K40	206744	460355-2	Relay
LS1	76188	145141-1	Speaker: PM 3-1/2" square
M1	218164	484363-6	Meter: 0-1 scale
M2	218285	484363-7	Meter: 0-200 MA
M3	218286	484363-11	Meter: VU -20 to +3 scale
M4	218164	484363-6	Meter: 0-1 scale
M5	53179	448347-3	Meter: elapsed time
P1	219544	474827-60	Connector: female, 9 contact
P2	219537	474827-3	Connector: male, 9 contact
P3	219538	474827-38	Connector: female, 11 contact
P4	219532	8720082-3	Connector: male, 3 contact
P5	219539	474827-39	Connector: female, 9 contact
P6	207408	8439039-4	Connector: male, 3 contact
P7	56539	458540-7	Connector: female, 3 contact
P8	219536	458540-16	Connector: female, 4 contact
P9	219540	474827-40	Connector: female, 7 contact
P10	219549	8978091-10	Connector: female, 3 contact
P11	219546	8720082-7	Connector: male, 4 contact
P12	219547	8720082-8	Connector: female, 4 contact

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
P13	207357	8439039-3	Connector: female, 3 contact
P14	52806A	8720082-6	Connector: female, 3 contact
P15	219545	474827-64	Connector: female, 20 contact
P16	219541	474827-43	Connector: male, 14 contact
P17 to P34			Not Used
P35	221796	474827-70	Connector: male, 24 contact
P36	219305	474827-61	Connector: male, 34 contact
R1A/B	221798	737881-4	Resistor: variable, 10,000/10,000 ohms, ±10%, 3 w
R2	218284	8439027-1	Resistor: variable, wire wound, 25,000 ohms, ±5%, 3 w
R3	95243	8971860-14	Resistor: variable, 100,000 ohms, ±10%, 2 w
R4	57402	8971860-116	Resistor: variable, 250,000 ohms, ±10%, 2 w
R5	218277	990730-401	Resistor: fixed, comp., 10,000 ohms, ±1%, ½ w
R6A/B	206023	427966-10	Resistor: variable, comp., 300/300 ohms, ±20%, 2 w
R7,R8		82283-74	Resistor: fixed, comp., 10,000 ohms, ±10%, ½ w
R9		90496-172	Resistor: fixed, comp., 3600 ohms, ±5%, 1 w
R10		82283-54	Resistor: fixed, comp., 220 ohms, ±10%, ½ w
S1,S2	219650	8439043-16	Switch: pushbutton, less colored button
S3,S4			Not Used
S5 to S9	219650	8439043-16	Switch: pushbutton, less colored button
S10			Not Used
S11	221805	8461425-1	Switch: toggle
S12	218280	8439066-1	Switch: rotary, single section, 5 position
S13	218279	8439067-1	Switch: rotary, 4 section, 7 position
S14	218282	8978045-2	Switch: micro
S15	221805	8461425-1	Switch: toggle
S16,S17	218282	8978045-2	Switch: micro
S18	221805	8461425-1	Switch: toggle
S19	218282	8978045-2	Switch: micro
S20 to S23			Not Used
S24,S25	219650	8439043-16	Switch: pushbutton, less colored button
S26	221805	8461425-1	Switch: toggle
S27 to S31			Not Used
S32	221805	8461425-1	Switch: toggle
T1	218276	8720093-1	Transformer: variable
XDS1 to XDS10			Not Used
XDS11A/B		8943520-86	Socket: lamp
	210554		Socket only
		8943520-386	Jewel only (white)
XDS12 To XDS27			Not Used
XDS28	205187	8867474-1	Socket: lamp
XDS29 to XDS31			Not Used
XDS32A		8943520-86	Socket: lamp
	210554		Socket only
		8943520-386	Jewel only - white
XDS32B		8943520-85	Socket: lamp
	210554		Socket only
		8943520-385	Jewel only - amber
XK1 to XK39			Not Used
XK40	68590	99100-4	Socket: relay
			Miscellaneous:
	219651	8446123-1	Button: push, red, small
	219652	8446123-2	Button: push, white
	219653	8446123-3	Button: light green, large
	219654	8446123-4	Button: push, amber
	219655	8446123-5	Button: red, large
	221797	8446123-7	Button: light green, small
	215876	721336-502	Knob: for T1
	30075	712336-507	Knob: control, black (9 used)
	221807	8514484-1	Knob: record
	221808	8515249-1	Knob: play
	221806	8514483-1	Lever: for record and play knob
	221809	8514482-501	Spacer Assembly: for record and play knob

RELAY FUNCTIONAL CHART (RECORD MODE)

Relay Number & Designation	*Energized By*	*Energizes Relay*	*De-energizes Circuit or Relay*	*Electrical Components Controlled*	*Through Connector*	*Notes*
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	Delegates control to local or remote control panel.
K5 MASTER RECORD	S5B, thru S1B, S2B contacts.	K6,K7,K23, K33,K20	K8, thru K6, K7 contacts.	RECORD light (DS5); remote RECORD light.	J34-13	
K6 AUDIO RECORD	K5	K11 (K15 thru S16B overridden by K5).		AUDIO light (DS6); remote AUDIO light.	J34-21	Cannot be released by AUDIO RELEASE when in RECORD mode.
K7 CUE RECORD	K5	K12 (K14 thru S17B overriden by K5).		CUE light (DS7); remote CUE light.	J34-24	Cannot be released by CUE RELEASE when in RECORD mode.
K11 AUDIO HEAD TRANSFER	K6			Audio Panel (204) K3,K2,K1 (mutes going into or out of RECORD mode).	J23-L	Transfers audio head.
K12 CUE HEAD TRANSFER	K7			Audio Panel (204) K6,K5,K4 (mutes going into or out of RECORD mode).	J23-C	Transfers cue head.
K23 RECORD AUX	K5	K26,K40	S15	Capstan Servo (404) K1,K2. Video Preamplifier (203) K1. Record Amplifier (104) K1. Reference Generator (407) K1,K2, K5, (thru S18).	J15-U J26-2 J25-2 J22-F	
K26 RECORD AUX	K23			Modulator (102) K1, thru K9 contacts. Demodulator (201) K2. Processing Amplifier (308) 5K2. Demodulator (201) S2C. Demodulator (201) K1.	J24-2 J27-3 J29-2 J29-4 J27-2	
K33 RUN/WIND	K5, thru K1 contacts.	K34,K21, K17,K37	K24			Opens C6 charge circuit.
K34 RUN/WIND POWER	K33	K37	K24,K18, K35,K36	HEAD HOUR meter (AC-LO) thru K20 contacts. HEAD HOUR meter (AC-HI).	J35-D J35-C	
K20 PLAY/RECORD	K5	K19,K31		HEAD HOUR meter (AC-LO) thru K34 contacts.		
K21** MOMENTARY DELAY	C6 discharge thru K33 contacts.		K31 (see note).			Delays energizing approximately 1/4 second.
K17 HEADWHEEL	K33, thru K27 contacts.		Local STOP light (DS1); remote STOP light.	Capstan Servo (404) K1,K2,K3,K6 (common negative). Headwheel Servo (504) K1. Capstan Servo (404) K6(motor). Headwheel Blower (208) AC-HI.	 J15-R J31-2 J15-X J30-3	
K40 GUIDE CONTROL	K23		R1-B	R1-A to Guide Servo (506) P1.	J16-P/R	

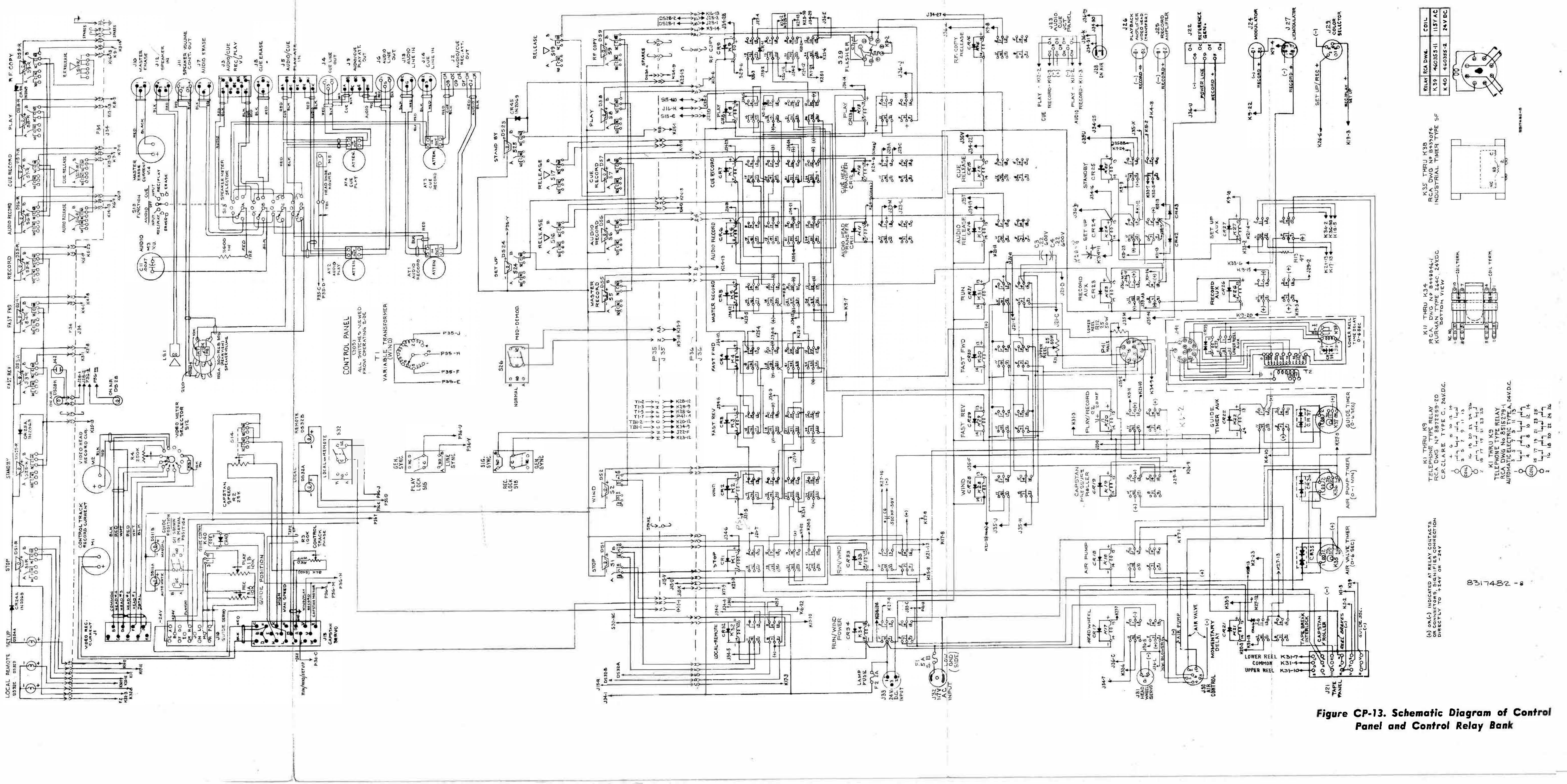


Figure CP-13. Schematic Diagram of Control Panel and Control Relay Bank

RELAY FUNCTIONAL CHART (RECORD MODE) Cont'd

Relay Number & Designation	Energized By	Energizes Relay	De-energizes Circuit or Relay	Electrical Components Controlled	Through Connector	Notes
K37** GUIDE TIMER	K34,K33, thru K22 contacts.	K22 after time delay.				
K22** GUIDE TIMER AUX	K34,K37		K37	Tape Transport Panel (200): Guide solenoid (L4), thru K4, K3,K2 contacts. Shorts S1 (tape break switch) for duration of K37 time delay.		
K19 CAPSTAN PRESSURE ROLLER	K20(+), K34(−).	K38		Demodulator (201) S2C. Tape Transport Panel (200): Capstan roller solenoid (L3), thru K21 contacts.	J29-4	1/4 second time delay.
K31 RUN	K20, thru K21 contacts.			Tape Transport Panel (200): Reel brake solenoids (L1,L2). Reel motors B2 B1 Common	J21-N/P J21-E J21-C J21-D	
K36* AIR PUMP TIMER	K34, thru K18 and K27 contacts, after STOP.	K18 after 40 second time delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			Energizes air valve (at terminal board 1TB2 in rack 1) 4 seconds after STOP.	J30-2	
K18* AIR PUMP	K36 and K34, thru K27 contacts.		K36,K35, 40 seconds after STOP.	Air Pump (509) K1. Headwheel Blower (208) AC-LO.	J30-1 J30-4	K18 de-energized.
K38** LOWER REEL TIME DELAY	K19, thru K39 contacts.	K39, after 2 second delay.		Lower reel motor voltage thru R12.	J41-3,5	
K39** LOWER REEL AUX	K38, thru K39 contacts.		K38			

* See *Control Relay Bank* circuit description.
** Note time delay involved.

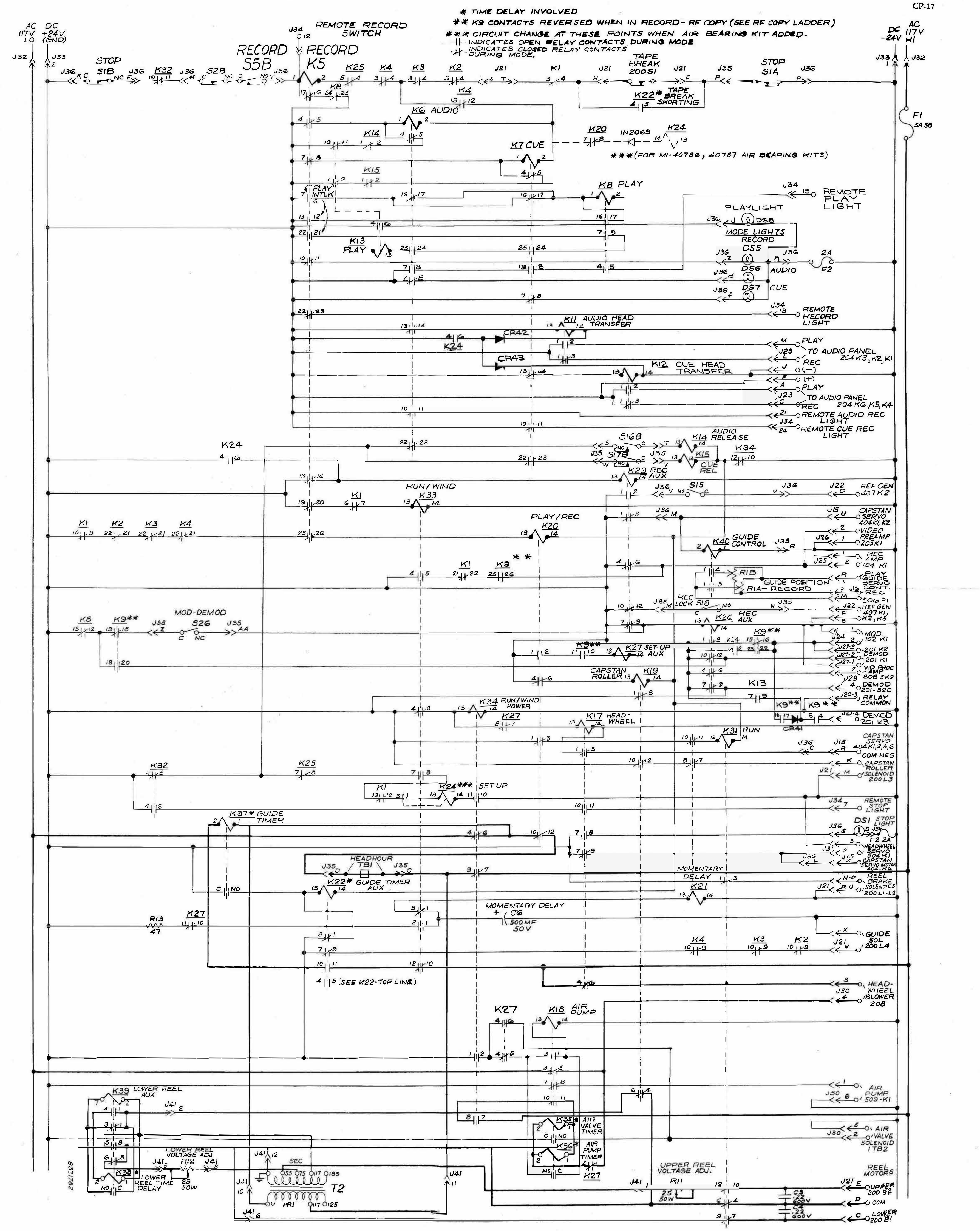


Figure CP-6. Control Ladder Diagram with Machine in Master RECORD Mode

RELAY FUNCTIONAL CHART (PLAY MODE)

Relay Number & Designation	Energized By	Energizes Relay	De-energizes Circuit or Relay	Electrical Components Controlled	Through Connector	Notes
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	Delegates control to local or remote control panel.
K13 PLAY	S8, thru K5, K2, K32, K1 contacts.	K8	K6, K7, K11 K12.	PLAY light (DS8).	J36-J	
K8 PLAY	K13	K33, K20	K5, S26	Remote PLAY light. Guide Servo (506) K3.	J34-15 J16-H	
K33 RUN/WIND	K8, thru K1 contacts.	K34, K21, K17, K37.	K24			Opens C6 charge circuit.
K34 RUN/WIND POWER	K33	K37	K24, K18, K35, K36.	HEAD HOUR meter (AC-LO) thru K20 contacts. HEAD HOUR meter (AC-HI).	J35-C J35-D	
K20 PLAY/RECORD	K8	K19, K31		HEAD HOUR meter thru K34 contacts.		
K21** MOMENTARY DELAY	C6 discharge thru K33 contacts.		K31 (see note).			Delays energizing approximately 1/4 second.
K17 HEADWHEEL	K33, thru K27 contacts.		Local STOP light (DS1). Remote STOP light.	Headwheel Servo (504) K1. Headwheel Blower (208) AC-HI. Capstan Servo (404) K6 (motor); K1, K2, K3, K6 (common negative).	J31-2 J30-3 J15-X J15-R	
K37** GUIDE TIMER	K34 & K33, thru K22 contacts.	K22 after time delay.				
K22 GUIDE TIMER AUX	K37, K34		K37	Tape Transport Panel (200): Guide solenoid (L4) thru K4, K3, K2 contacts. Shorts S1 (tape break switch) for duration of K37 time delay.	J21-V	
K19 CAPSTAN PRESSURE ROLLER	K20(+), K34(−).	K38		Demodulator (201) S2C. Tape Transport Panel (200): Capstan roller solenoid (L3) thru K21 contacts.	J29-4 J21-K	1/4 second delay.
K31 RUN	K20, thru K21 contacts.			Tape Transport Panel (200): Reel brake solenoids (L1, L2). Reel motors B2 B1 Common	J21-N/P J21-E J21-C J21-D	1/4 second delay.
K36* AIR PUMP TIMER	K34, thru K27, K18 contacts after STOP.	K18 after 40 second delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			Energizes Air Valve (at terminal board 1TB2 in rack 1) 4 seconds after STOP.	J30-2	
K18* AIR PUMP	K36, thru K34 & K27 contacts.		K35, K36 40 seconds after STOP.	Air Pump (509) K1. Headwheel Blower (208) AC-LO.	J30-1 J30-4	K18 de-energized.
K38** LOWER REEL TIME DELAY	K19, thru K39 contacts.	K39 after 2 second delay.		Lower reel motor voltage thru R12.	J41-3, 5	
K39 LOWER REEL AUX	K38, thru K19 contacts.		K38			

* See *Control Relay Bank* circuit description.
** Note time delay involved.

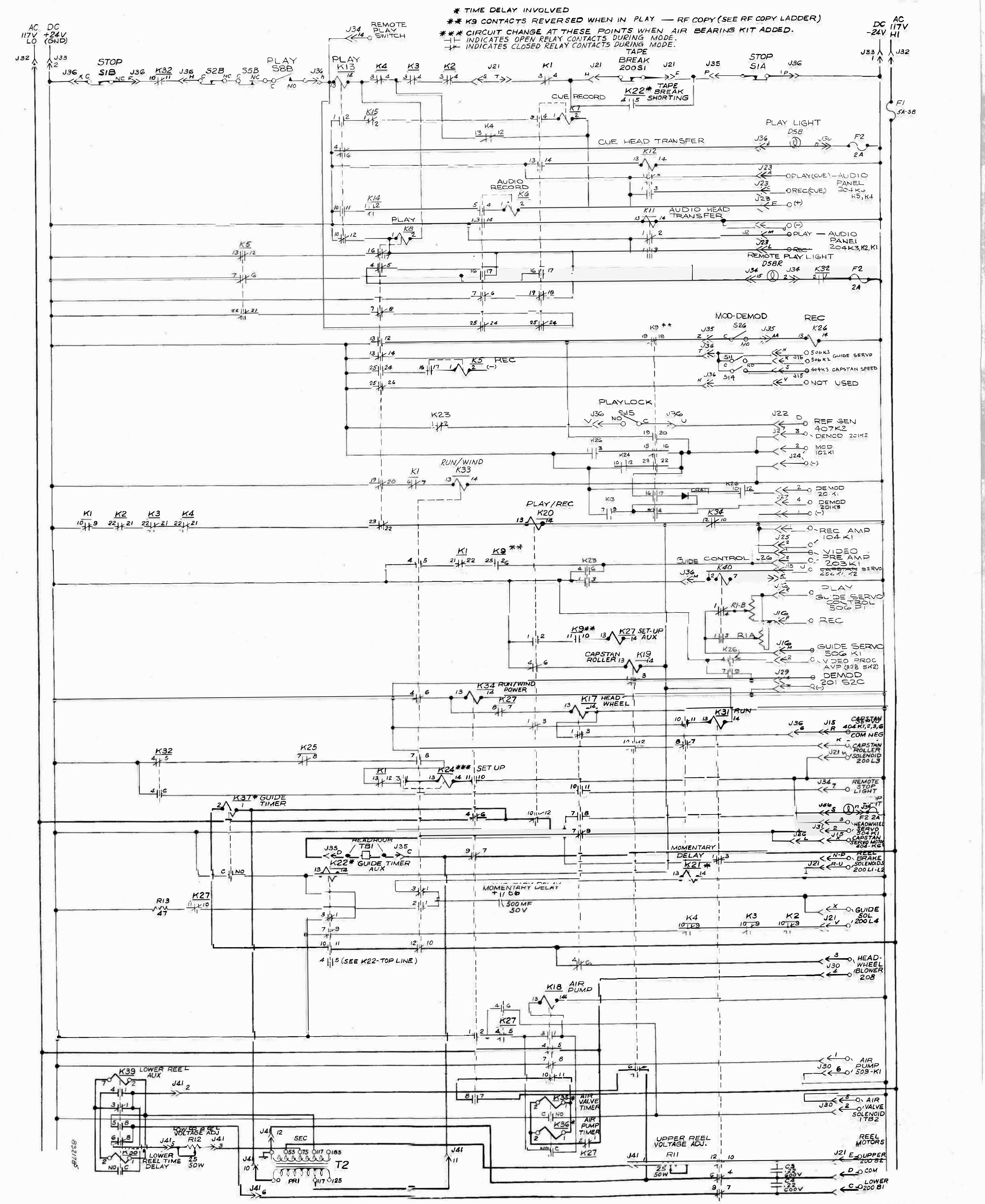


Figure CP-7. Control Ladder Diagram with Machine in PLAY Mode

RELAY FUNCTIONAL CHART (WIND MODE)

Relay Number & Designation	*Energized By*	*Energizes Relay*	*De-energizes Circuit or Relay*	*Electrical Components Controlled*	*Through Connector*	*Notes*
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	Delegates control to local WIND or to remote FAST FORWARD or FAST REVERSE.
K2 WIND	S2B, thru K32, S1 contacts.	K28, K33	K3, K4, K5, K6, K7, K8, K9	Opens guide solenoid (L4) on Tape Transport Panel (200).	J21-V	
K28 WIND	K2, thru K21 contacts and CR46; K34.			Tape Transport Panel (200): Reel Brake solenoids L1, L2. Reel Motors Upper (B2) } All controlled Common } thru K31 Lower (B1) } contacts	J21-P/N J21-E J21-D J21-C	1/4 second delay by K21.
K33 RUN/WIND	K2, thru K1 contacts.	K21, K34, K37, K17	K25, K24			
K34 RUN/WIND POWER	K33	K37	K24, K18, K35, K36			
K21** MOMENTARY DELAY	C6 discharge thru K33 contacts.		K28 (see note).			Delays energizing approximately 1/4 second.
K17 HEADWHEEL	K33, thru K27 contacts.		Local STOP light (DS1). Remote STOP light.	Headwheel Servo (504) K1. Headwheel Blower (208) AC-HI. Capstan Servo (404) K6 (motor), K1, K2, K3, K6 (common negative).		J31-2. J30-3. J15-X. J15-R.
K37** GUIDE TIMER	K34 and K33, thru K22 contacts.	K22 after time delay.				
K22** GUIDE TIMER AUX	K37, K34		K37	Tape Transport Panel (200): Shorts S1 (tape break switch) for duration of K37 time delay.		
K36* AIR PUMP TIMER	K34, thru K18, K27 contacts after STOP.	K18 after 40 second delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			Energizes Air Valve solenoid (at terminal board 1TB2 in rack 1) 4 seconds after STOP.	J30-2	
K18* AIR PUMP	K36, thru K34 and K27 contacts.		K36, K35 40 seconds after STOP.	Air Pump (509) K1. Headwheel Blower (208) AC-LO.	J30-1 J30-4	K18 de-energized.

* See *Control Relay Bank* circuit description.

** Note time delay involved.

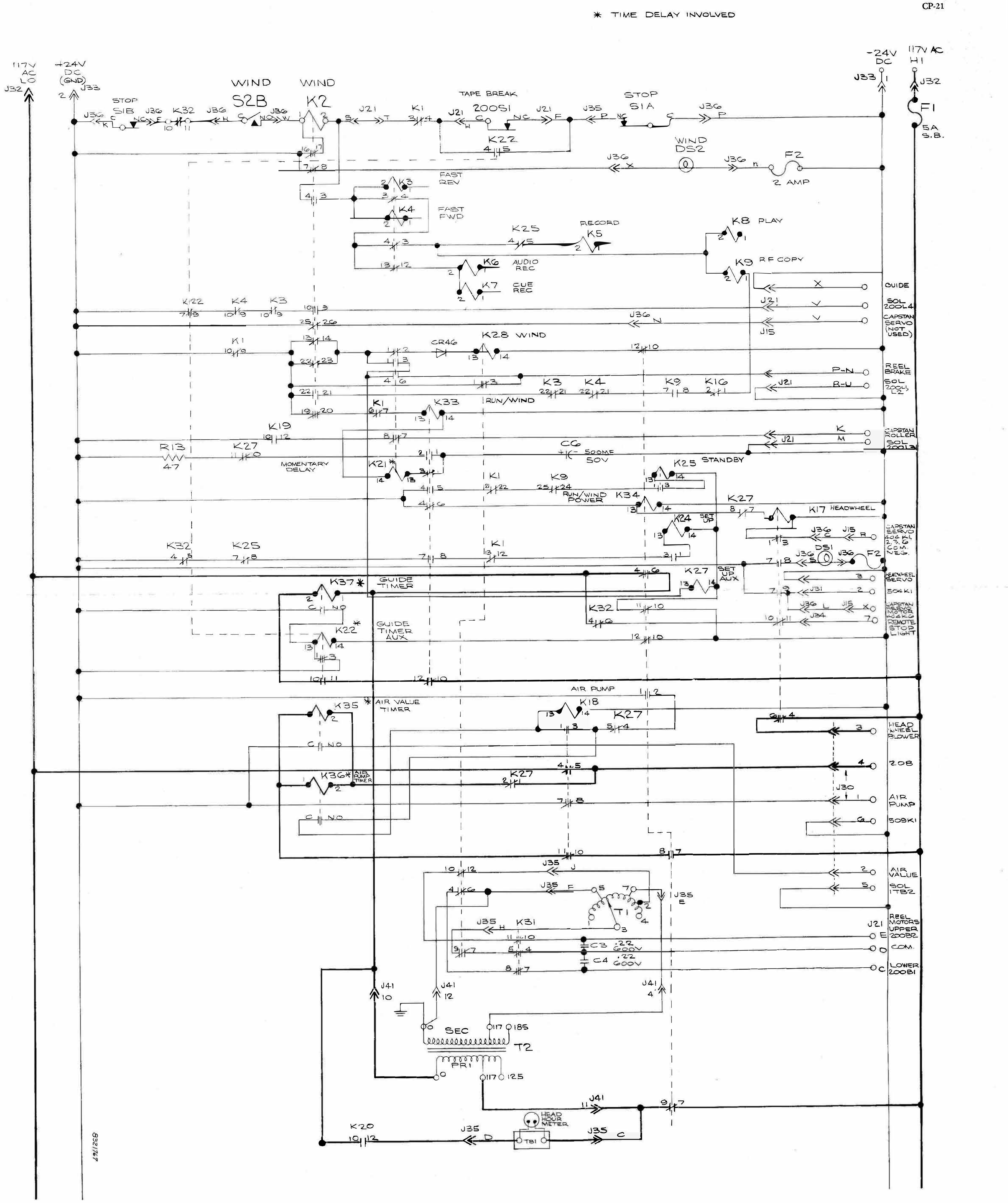


Figure CP-8. Control Ladder Diagram with Machine in WIND Mode

RELAY FUNCTIONAL CHART (SET-UP MODE)

Relay Number & Designation	*Energized By*	*Energizes Relay*	*De-energizes Circuit Or Relay*	*Electrical Components Controlled*	*Through Connector*	*Notes*
K24 SETUP	S24B, thru K32,K25,K33, K1 contacts.	K27,K11, K12,K23		SET UP light (DS24).		Local only.
K27 SET UP AUX	K24, thru K25,K9 contacts.	K17,K21	K36,K35,K18	Air valve solenoid (at terminal board 1TB2 in rack 1). Overrides K35 contacts.	J30-2	Air valve energized continuously in SET UP.
K11 AUDIO HEAD TRANSFER	K24, thru CR42			Audio Panel (204) K3,K2,K1. Audio Head Transfer.	J23-L	
K12 CUE HEAD TRANSFER	K24, thru CR43			Audio Panel (204) K6, K5, K4. Cue Head Transfer.	J23-C	
K23 RECORD AUX	K24	K26	S15	Capstan Servo (404) K1,K2. Video Preamplifier (203) K1. Record Amplifier (104) K1. Reference Generator (407) K1,K2, K5, (thru S18).	J15-U J26-2 J25-2 J22-F	
K26 RECORD AUX	K23			Modulator (102) K1, thru K9 contacts. Demodulator (201) K2. Processing Amplifier (308) 5K2. Demodulator (201) S2C. Demodulator (201) K1.	J24-2 J27-3 J29-2 J29-4 J27-2	
K17 HEADWHEEL	K27		Local STOP light (DS1). Remote STOP light.	Headwheel Blower (208) AC-HI. Capstan Servo (404) K1,K2,K3,K6 (common negative). Headwheel Servo (504) K1. Capstan Servo (404) motor (K6).	J30-3 J15-R J31-2 J15-X	
K21** MOMENTARY DELAY	C6 discharge thru K27,K33 contacts.			Tape Transport Panel (200): Momentarily energizes reel brake solenoids (L1 & L2).	J21-R/U	Approximately 1/4 second brake release.
K36* AIR PUMP TIMER	K27, thru K18 and K34 contacts, after STOP.	K18, after 40 second delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			See K27.	See K27.	
K18* AIR PUMP	K36, thru K34 & K27 contacts.		K36 & K35 40 seconds after STOP.	Headwheel Blower (208) AC-LO. Air Pump (509) K1.	J30-4 J30-1	K18 de-energized.

* See *Control Relay Bank* circuit description.
** Note time delay involved.

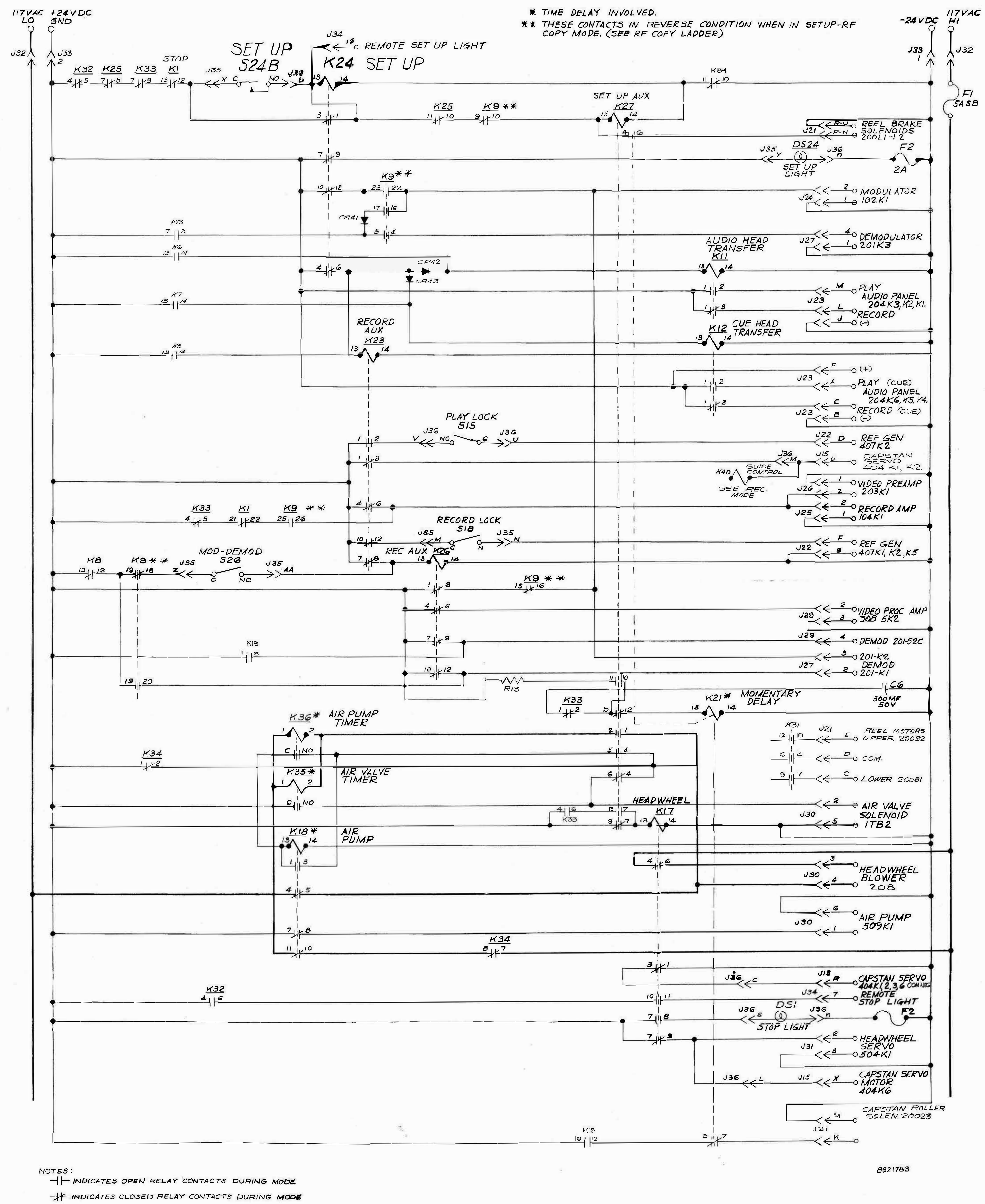


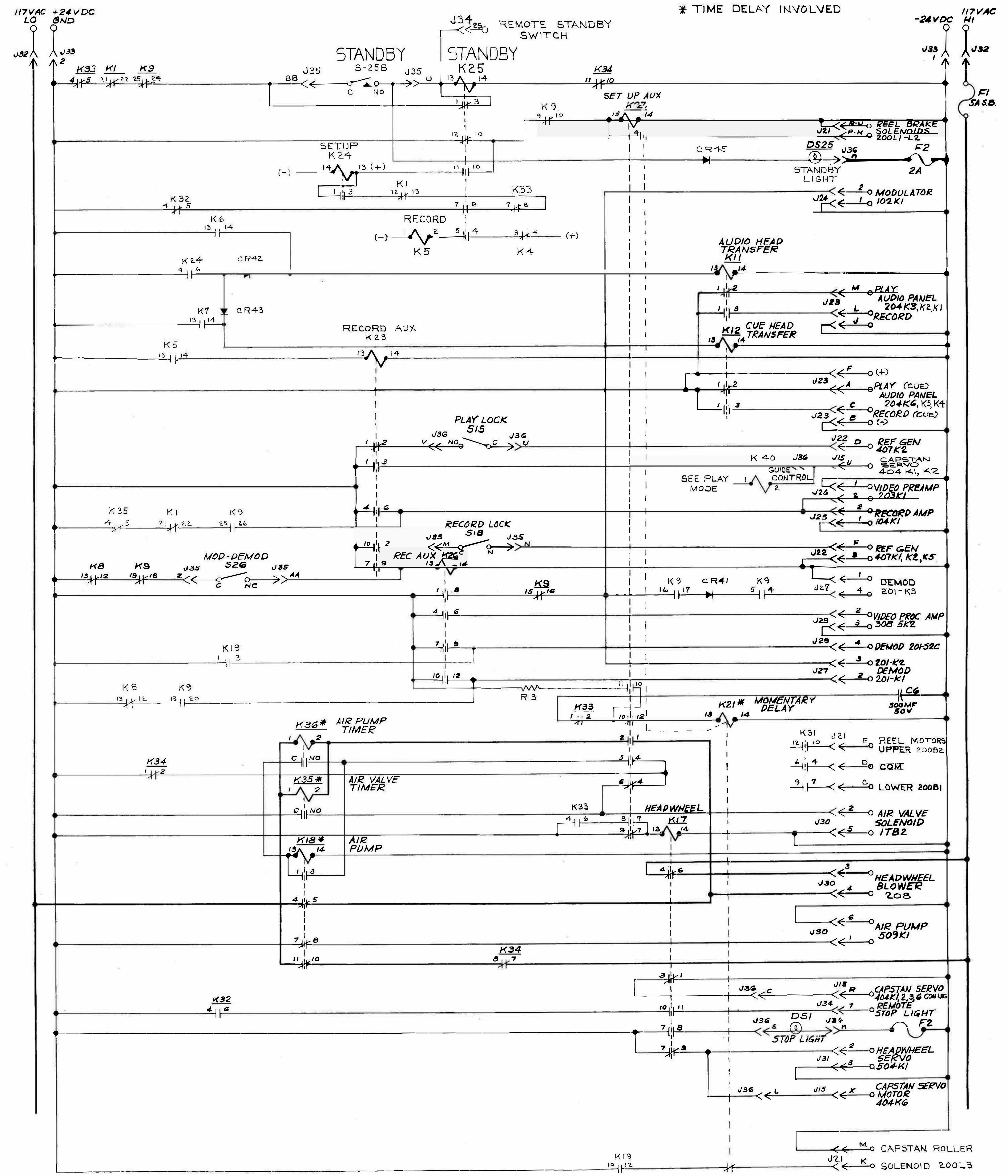
Figure CP-9. Control Ladder Diagram with Machine in SETUP Mode

RELAY FUNCTIONAL CHART (STANDBY MODE)

Relay Number & Designation	Energized By	Energizes Relay	De-energizes Circuit or Relay	Electrical Components Controlled	Through Connector	Notes
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	No effect on STANDBY.
K25 STANDBY	S25B thru K33, K1,K9 contacts.	K27, thru K9 contacts.	K24,K5			
K27 SET UP AUX	K25	K17,K21	K36,K35	Air Valve solenoid (at terminal board 1TB2 in rack 1). Overrides K35 contacts.	J30-2	Air Valve energized continuously in STANDBY.
K26 RECORD AUX	S26			Modulator (102) K1, through K8, K9 contacts. Demodulator (201) K2. Processing Amplifier (308) 5K2. Demodulator (201) S2C. Demodulator (201) K1.	J24-2 J27-3 J29-2 J29-4 J27-2	MOD-DEMOD switch.
K21** MOMENTARY DELAY	C6 discharge thru K27,K33 contacts.			Tape Transport Panel (200): Momentarily energizes Reel Brake solenoids L1,L2.	J21-R/U	Approximately 1/4 second brake release.
K17 HEADWHEEL	K27		Local STOP light (DS1). Remote STOP light.	Headwheel Blower (208) AC-HI. Capstan Servo (404) K1,K2,K3,K6 (common negative). Headwheel Servo (504) K1. Capstan Servo (404) motor (K6).	J30-3 J15-R J31-2 J15-X	
K36* AIR PUMP TIMER	K34, thru K18 & K27 contacts after STOP.	K18 after 40 second delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			See K27.	See K27.	
K18* AIR PUMP	K36 and K34, thru K27 contacts.		K36,K35 40 seconds after STOP.	Headwheel Blower (208) AC-LO. Air Pump (509) K1.	J30-4 J30-1	K18 de-energized.

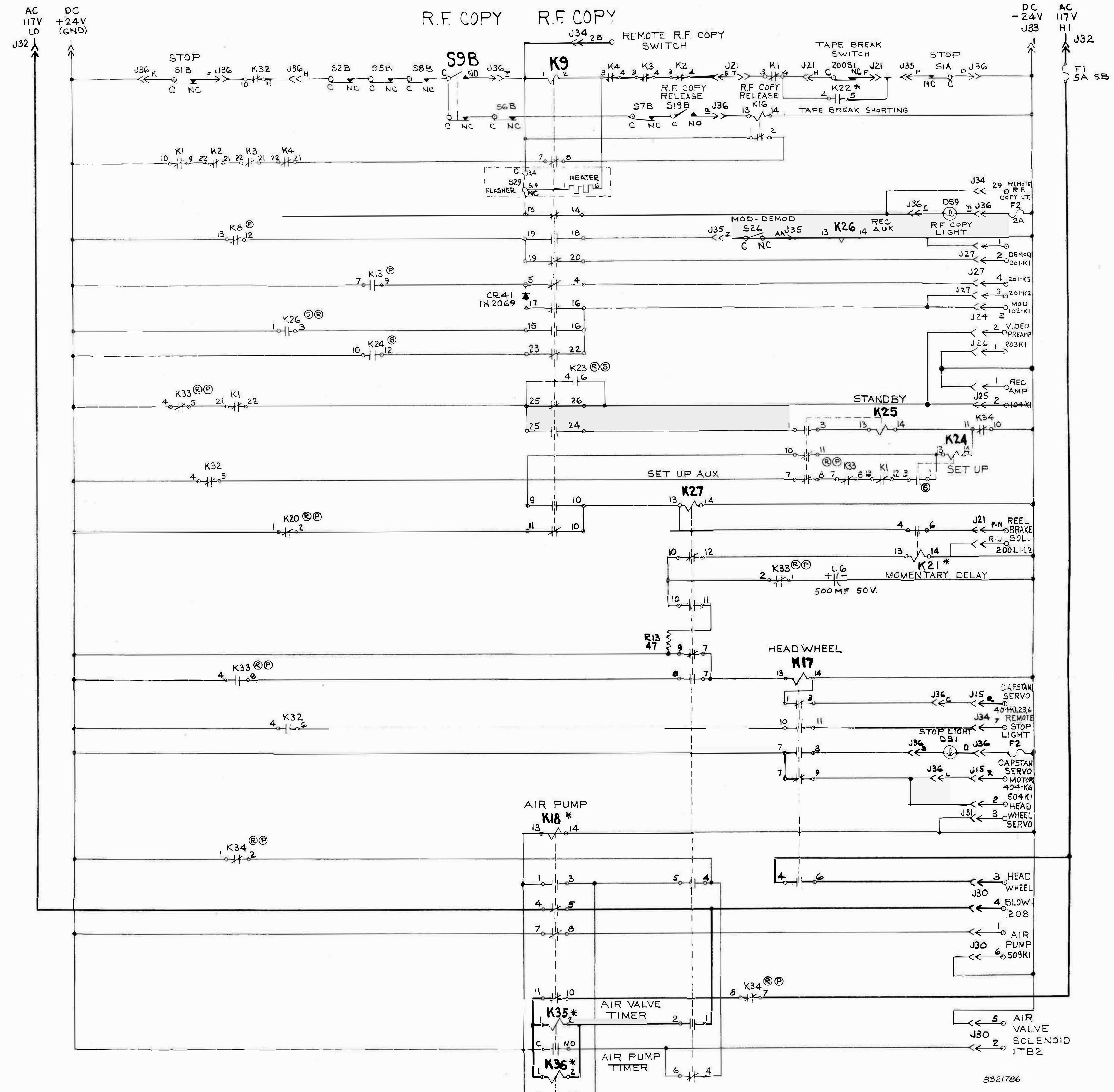
* See *Control Relay Bank* circuit description.

** Note time delay involved.



NOTES:
—| |— INDICATES OPEN RELAY CONTACTS DURING MODE
—|/|— INDICATES CLOSED RELAY CONTACTS DURING MODE

Figure CP-10. Control Ladder Diagram with Machine in STANDBY Mode



RELAY FUNCTIONAL CHART (RF COPY MODE)

Relay Number & Designation	*Energized By*	*Energizes Relay*	*De-energizes Circuit or Relay*	*Electrical Components Controlled*	*Through Connector*	*Notes*
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	Delegates control to local or remote control panel.
K9 RF COPY	S9B, thru S1 K32, S2, S5, S8	K27	K25	Demodulator (201) K1. Record Amplifier (104) K1. Video Preamplifier (203) K1.	J27-2 J25-2 J26-2	
K16 RF COPY RELEASE	S19B, thru S1 K32, S2, S5, S8, S9, S6, S7.		K9, thru K9, K4, K3, K2, K1 contacts.			
K27 SET UP AUX	K9, thru K20 contacts.	K21, K17	K18	Air valve solenoid (at terminal board 1TB2 in rack 1). Overrides K35 contacts.	J30-2	Air Valve energized continuously in SETUP.
K21** MOMENTARY DELAY	C6 discharge thru K27, K33 contacts.			Momentarily energizes reel brake solenoids (L1, L2) on Tape Transport Panel (200).	J21-R/U	Approximately 1/4 second delay.
K17 HEADWHEEL	K27		Local STOP light (DS1); remote STOP light.	Headwheel Blower (208) AC-HI. Capstan Servo (404) K1, K2, K3, K6 (common negative). Capstan Servo (404) motor (K6).	J30-3 J15-R J15-X	
K36* AIR PUMP TIMER	K27, thru K18, K34 contacts after STOP.	K18, after 40 second time delay.				
K35* AIR VALVE TIMER	(In parallel with K36.)			See K27.	See K27.	
K18* AIR PUMP	K36, thru K34 and K27 contacts.		K36 and K35, 40 seconds after STOP.	Headwheel Blower (208) AC-LO. Air Pump (509) K1.	J30-4 J30-1	K18 de-energized.

* See *Control Relay Bank* circuit description.
** Note time delay involved.

NOTES

* INDICATES TIME DELAY INVOLVED.
CONTACTS AS SHOWN ARE FOR MACHINE IN R.F COPY MODE ONLY.

R FOR RECORD- RF COPY MODE, CONTACTS FOR RELAYS K26, K23, K33, K27, K20, K34 WILL BE REVERSE OF WHAT IS SHOWN.

P FOR PLAY- RF COPY MODE, CONTACTS FOR RELAYS K34, K33, K27, K20, K13, K8 WILL BE REVERSE OF WHAT IS SHOWN.
OPERATION IN AUDIO- RF COPY OR CUE- RF COPY IS THE SAME AS PLAY-RF COPY.

S FOR SET UP- RF COPY MODE, CONTACTS FOR RELAYS K24, K26, K23 WILL BE REVERSE OF WHAT IS SHOWN.

Figure CP-11. Control Ladder Diagram with Machine in RF COPY Mode

RELAY FUNCTIONAL CHART (AUDIO-CUE MODE)

Relay Number & Designation	Energized By	Energizes Relay	De-energizes Circuit or Relay	Electrical Components Controlled	Through Connector	Notes
K32 LOCAL-REMOTE	S32			All mode switches in REMOTE (local STOP and STANDBY still function).	J34	Delegates control to local or remote control panel.
K6 AUDIO RECORD	S6B	K11, K8, K14, thru S16B.	Remote PLAY light. K13.	AUDIO light (DS6). Remote AUDIO light.	J36-d J34-21	
K11 AUDIO HEAD TRANSFER	K6			Audio Panel (204) K3, K2, K1	J23-C	
K14 AUDIO RELEASE	S16B, thru K6 contacts.		K6			
K7 CUE RECORD	S7B	K12, K8, K15, thru S17B.	Remote PLAY light. K13.	CUE light (DS7). Remote CUE light.	J36-f J34-24	
K12 CUE HEAD TRANSFER	K7			Audio Panel (204) K6, K5, K4.	J23-L	
K15 CUE RELEASE	S17B, thru K7 contacts.		K7			

NOTES: Remainder of AUDIO-CUE mode is identical to PLAY mode (from relay K8 to end of PLAY mode chart).
For AUDIO only, relays K7 and K12 are not energized, and relay K15 is not operative.
For CUE only, relays K6 and K11 are not energized, and relay K14 is not operative.

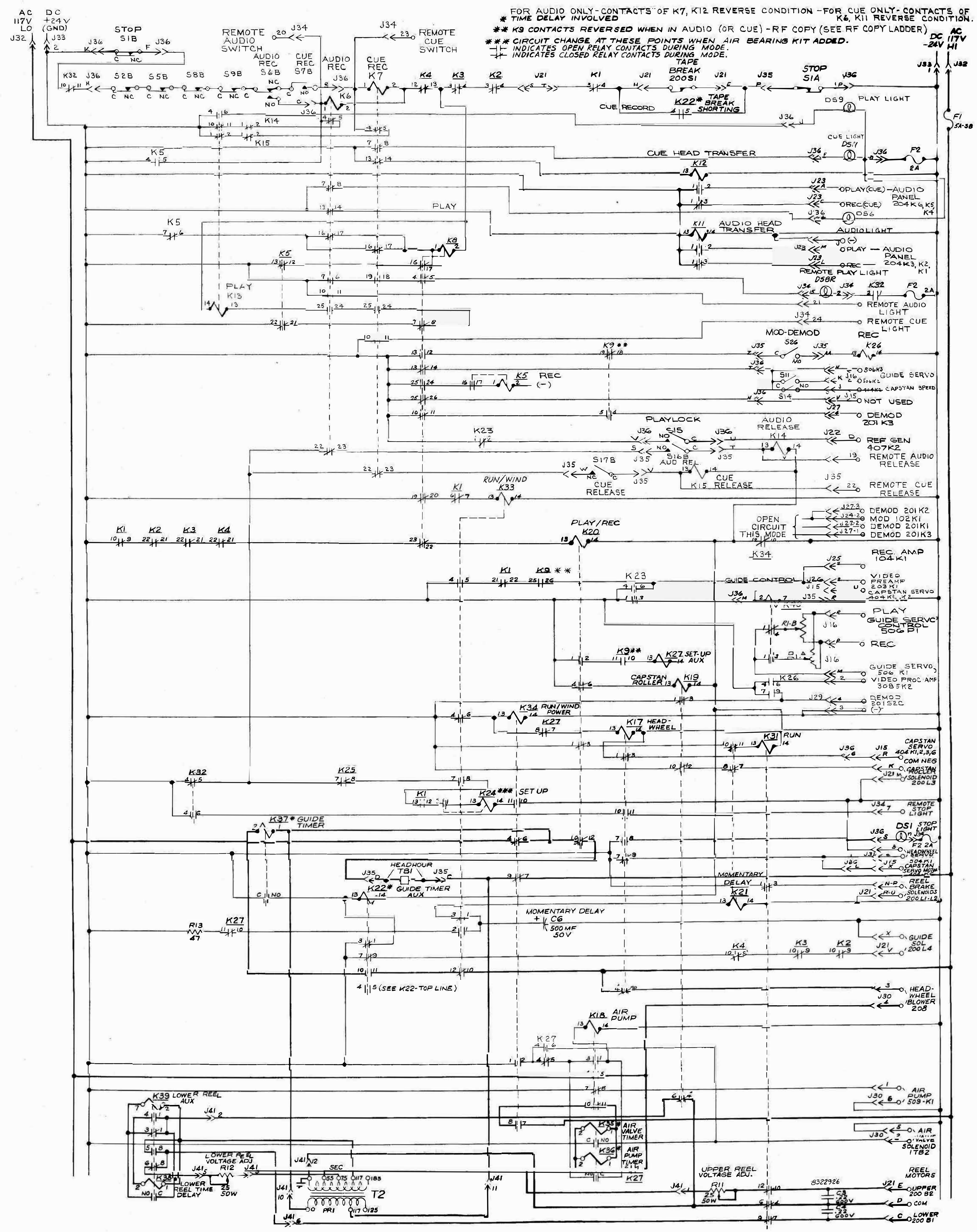


Figure CP-12. Control Ladder Diagram with Machine in AUDIO and CUE RECORD Modes

CRO Waveform Monitor

UNIT 306

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WB 671

IB-31123

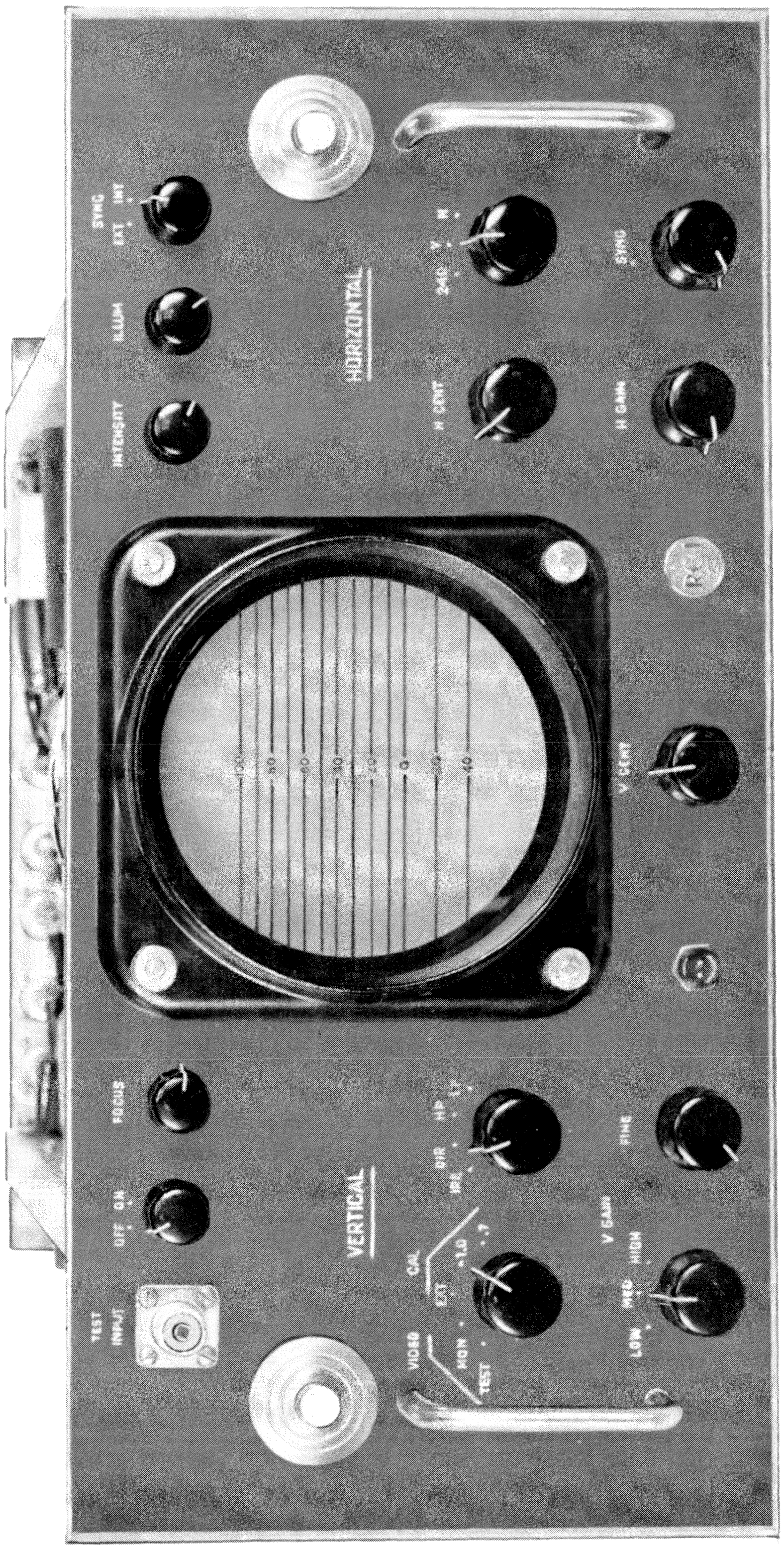


Figure CRO-1. CRO Waveform Monitor

TECHNICAL DATA

Power Required

105–128 volts, 50–60 cps, 295 watts
(from Circuit Breaker No. 2)

Input Impedance

Monitor Video Input: Bridging, 75-ohm external termination

Test Video Input: High impedance (0.5 meg.—43 $\mu\mu$f)

Sync Input: Bridging, 75-ohm external termination

Calibrate Input: Bridging

TW Input: Bridging

Vertical Sensitivity

30 millivolts per centimeter

Sweep Rate

240 cps, 30 cps (2 fields) or 7.9 KC (2 lines)

Frequency Response

Flat from 60 cps to 5 mc; down approx. 3 db at 10 mc*

Synchronization

TW IN—240 cps synchronization (external only)
SYNC IN—H or V sync (internal or external)

Vertical Input Signals

CRO Monitor Switcher (selectable)
Test Input (from external probe)

Tube Complement

1	2X2A
1	5651
1	5AQP-1
1	5U4GB
1	6AL5
3	6AN8
1	6AS7/6080
1	6AU8
2	6AW8A
5	6BQ7A
2	6CL6
1	6U8A
1	6X4
1	12AX7
3	OA2
1	VXR-2500

* RESPONSE selector switch permits selecting any of four frequency response characteristics. See text under *Description.*

DESCRIPTION

The CRO Waveform Monitor (figure CRO-1) is a wide-band sensitive oscilloscope designed for observation of both monochrome and color-television waveforms. The horizontal gain control (H GAIN) on the front panel permits expanding the sweep for close investigation of the signal waveforms.

During operation of the tape recorder, any one of 11 waveforms can be monitored by pressing a push-button switch on the CRO-monitor switcher panel, which is mounted directly below the CRO waveform monitor. For details refer to the instruction book on the CRO-Monitor Switcher (unit 307).

Waveforms at other test points in the System may also be observed by placing the input selector switch of the waveform monitor in the TEST position and connecting the external probe to the test point to be examined. Normal care must be exercised in using the external direct probe since loading of high impedance test points may distort the observed waveform.

The faceplate of the cathode ray tube is provided with a graticule calibrated in Standard IRE units for a convenient reference in setting up and checking video waveforms. The rulings on the graticule ascend from a zero reference to 100 in numerical graduations of 10 and descend from the same zero reference to 40, making a numerical total of 140.

Operating Controls

The controls on the front panel of the CRO waveform monitor enable the operator to utilize fully the features of the instrument with the television tape recorder. The controls are listed below.

VIDEO-CAL Selector Switch: Permits selection of one of the following inputs.

(a) VIDEO TEST — high impedance TEST INPUT jack on front panel.

(b) VIDEO MON — normal bridging input jack on rear of chassis from CRO monitor switcher.

(c) CAL EXT — input jack on rear of chassis for bridging an external calibrating source.

(d) CAL 1.0 — switches an internal 1.0 volt peak-to-peak 60-cycle square wave to the vertical input for calibrating CRO graticule.

(e) CAL 0.7 — switches on internal 0.7 volt peak-to-peak 60-cycle square wave to the vertical input for calibrating CRO graticule.

Response Selector Switch: Changes frequency response of vertical amplifier to any of the following characteristics:

(a) IRE — an IRE specified roll-off (see figure CRO-2).

(b) DIR — Flat from 60 cps to 5 mc (−3 db at 10 mc).

(c) HP — high pass filter with slope approaching 12 db per octave below 0.8 mc.

(d) LP — low pass filter with slope approaching 12 db per octave above 8 mc.

V GAIN and V CENT Controls

LOW, MED, HIGH, D.G. — vertical amplifier gain range switch. The D.G. position is used when accurate differential gain measurements are necessary. (Not available on all models.)

FINE — vertical amplifier venier gain control.

V CENT — vertical centering control, permits positioning of waveforms on CRO face.

240-V-H Sweep Selector

(a) 240 — permits selection of a 240 cycle sweep rate for displaying 240 cycle information as required in the television tape recorder.

(b) V — 30 cycle sweep rate for a two-field display.

(c) H — a 7.9 KC sweep rate for a two-line display.

H GAIN and H CENT Controls

H GAIN — horizontal gain control enables the video display to be expanded 25 times to permit close inspection of signals such as horizontal and vertical sync intervals or the number of cycles of color burst.

H CENT — horizontal centering control for positioning of waveforms on CRO face.

Sync Controls

SYNC: lock-in control for 240, V, and H sweep speeds.

SYNC EXT-INT selector switch: permits selection of internal or external sync source for locking of sweep rate in H or V positions.

Miscellaneous Controls

ON-OFF switch: applies and removes a-c power to the monitor.

FOCUS control: permits focusing the spot on the CRO tube screen.

INTENSITY: CRO intensity control.

ILLUM: graticule edge lighting control.

Circuit

The circuits may be divided into three general groups. Referring to the schematic diagram, figure CRO-10, and block diagram figure CRO-9, the chain of tubes along the top of the diagram comprises the vertical deflection circuits; those along the bottom comprise the horizontal deflection circuits; and those to the right comprise the dc circuits generating B+ and high voltages for the kinescope.

Vertical Deflection

The input signal to the vertical deflection circuits is selected by switch S1A. This switch is normally placed in the MON position which connects the grid of V1A to J3 and J4, MON VIDEO INPUT. The output of the CRO monitor switcher (unit 307) is fed to J3 with J4 terminated in 75 ohms.

For maintenance of the system where it is desired to use the external probe of the waveform monitor, S1A is placed in the TEST position, connecting V1A to J5, VIDEO TEST INPUT. The other three positions of S1A are used to calibrate the deflection of the waveform monitor. In the EXT position, an external calibrating voltage may be applied to V1A thru J1, EXT CAL INPUT. In the CAL 1V or CAL .7V positions, an internally generated square-wave calibrating voltage is applied to V1A. The calibrating square wave is generated by applying the 6.3 ac filament voltage through S1B to clipping diodes CR1 and CR2. The clipping level is pre-adjusted at the factory with potentiometer, P2, *CALIBRATE ADJ,* (see figure CRO-7) to give 1 v peak-to-peak at point "a" and .7 v peak-to-peak at point "b" (refer to Schematic Diagram).

The desired signal is coupled to the grid of video amplifier, V1A. Amplifier V1A and cathode follower, V1B, contain the manual gain control circuits for the vertical deflection amplifier chain. These circuits accommodate a wide range of input signal levels without overload while maintaining a flat frequency response to 5 mc.

A three position switch, S3, provides HIGH, MEDIUM, and LOW ranges of amplification. Some models of the CRO monitor may provide a fourth position (DIFFERENTIAL GAIN) which is useful when the monitor is used with other equipments.

S3 performs three functions in effecting the change in gain: First, S3A selects different values of cathode resistance for V1A. Secondly, S3B selects different feedback paths from the cathode of V1B to the grid of V1A. Third, S3C selects different values of bias to the grid of V1A for the proper operating point for each range. The circuit constants are such that a

reading of 0 volts between test points J8 and J9 on the chassis indicates that the operating points for each range have been correctly set by potentiometers P1, P15, and P16 respectively. (See *Adjustments.*)

A flat frequency response to 5 mc is set by adjustment of shunt peaking coil, L1, in the plate circuit of V1A on the HIGH range, and by adjustment of cathode peaking coils, L3 and L2, on the MEDIUM and LOW ranges. (See *Alignment.*)

A front panel control, V. GAIN (potentiometer P9) provides a vernier gain adjustment of the vertical deflection amplifier.

From cathode follower V1B, the signal is coupled to amplifier V2A thru switch S2, Frequency Response Selector. The CRO waveform monitor is normally used with S2 in the DIRECT position. In this position, the signal is connected directly from V1B to V2A for a full 5 mc bandwidth. However, three other positions are provided: IRE, LP, and HP.

In the IRE position, the signal passes through a filter which provides a roll off in frequency response (see figure CRO-2) corresponding to that specified by the IRE standard. Capacitor, C51 is adjusted for 6 db down at 1.55 mc in accordance with the standard.

In the LP position, the signal passes through a low pass filter which is set for minimum output at 3.58 mc by adjustment of coil L5.

In the HP position, the signal passes through a high pass filter with the low frequency roll off, adjusted by C7 and L4, set to give a 1 mc output equal to the 1 mc output of the low pass filter. The procedure for alignment of these filters is described in the Section on *Alignment.*

The signal is cathode coupled from amplifier V2A to amplifier V3A and fed balanced from their plate circuits to cathode followers, V4A and V4B. The signal from the cathodes of V4A and V4B is fed to the output stages, V5 and V7, which drive the vertical deflection plates of cathode ray tube V26. Negative feedback from the plates of V5 and V7 to the cathodes of V2A and V3A stabilizes the performance and increases the frequency response. Capacitors, C10 and C13 in the feedback path are adjusted for flat response to 5 mc (see *Alignment)*

A DC Setter circuit employs feedback from the plates of the output tubes to the grid of V2A, providing an extremely stable dc reference for the tips of sync over a 5 to 1 range of input signal amplitude. The V6 diodes detect the voltage representing the tips of sync. That voltage is compared to a reference voltage in a resistance bridge, and the error voltage is coupled to the grids of dc amplifiers, V2B and V3B. The amplified error voltage at the plate of V2B is applied to the grid of V2A, correcting any shift in the sync tip reference. The reference voltage in the resistance bridge is taken from dual potentiometer, P4, (the V. CENTERING Control) to permit positioning of the waveform on the cathode ray tube. Tube V8 provides a constant voltage to stabilize the operation of critical circuits.

Horizontal Deflection

In the horizontal deflection circuits, a choice of three different sweep rates is available. The selection of a horizontal sync rate, a vertical sync rate, or 240 cps rate is made by placing S4, SWEEP SPEED SELECTOR, in the desired position. The synchronizing signal is coupled through S4A to the grid of V9A. The 240 cps sync signal is coupled directly to S4A from J12 or J13, TW 240 IN.

Either external or internal H and V sync signals may be used, depending on the position of S5, EXT-INT. If S5 is on the EXT position, external sync is coupled from J6 or J7 through isolation amplifier, V9B, to S4A. If S5 is on the INT position, a sample of the composite video signal is taken from the cathode of Video Amplifier, V1.

Tubes V9A, V13B, V10A and V10B are used to strip the sync pulses from the composite video signal when internal sync is used to trigger the horizontal deflection generator. External sync pulses or 240 cps pulses which do not contain video information are also passed through these circuits to strip off any spurious information which may be present. The pulse output of V10B is coupled to the grid of Sawtooth Generator, V12, through a differentiating network consisting of C20 and R87 or through integrating network, N1.

If S4 is placed in the H position, the stripped sync (int. or ext.) is differentiated, and the negative spikes from the horizontal sync pulses, equalizing pulses, and vertical serrations are passed through diode CR3 to the grid of V12. In the V or 240 position, stripped sync or 240 cps pulses are passed through the integrator N1 to the grid of V12. The time constant of the integrator is such that the relatively narrow H pulses and equalizing pulses in sync will not pass. An output from the integrator is obtained only from the wide vertical sync pulse (or 240 pulse in 240 position).

V12 is an astable, cathode-coupled multivibrator whose free running frequency is determined by the time constant from the plate of V12A to the grid of V12B. If the free running frequency is close to the

desired frequency (or a multiple) trigger pulses applied to the grid of V12A will cause it to lock to the applied pulses. The free running frequency is adjusted with potentiometer P5 (SYNC) on the front of the unit, to lock the frequency for a stable waveform on the oscilloscope. In order that the waveform will remain locked without readjustment of P5 when switching between H, V, and 240, internal vernier adjustments are provided for each of these positions. They are P6 for V, C24 for H, and R17 for 240. Proper set up for these controls is described in the section on *Adjustments.*

The sawtooth voltage for horizontal deflection is generated by charging of capacitor C36 through R91 and R163 when V12B is cut off. Capacitor C36 is discharged very rapidly through V12B during the short interval when it is conducting. For the relatively long period of the V or 240 rate, an additional capacitor, C28, is switched in parallel with C36. Capacitor C36 (see figure CRO-8) is adjusted for the H position to make the amplitude of the sawtooth voltage equal to the amplitude of the sawtooth when using the V position. This is observed as equal sweep lengths on the oscilloscope (see *Adjustments*).

The capacitor charging voltage is coupled to the grid of a bootstrap amplifier, V13A, which improves the linearity of the sawtooth voltage by increasing the apparent voltage to which C36 is charging. This is accomplished by positive feedback from the cathode of V13A through capacitor, C49.

The sawtooth voltage is applied to the grid of driver stage, V15A, from the H GAIN potentiometer, P7, in the cathode of V13A. It is cathode coupled to the other driver stage, V16A, and direct coupled from the plates of the driver stages to the push-pull output stages V15B and V16B. The signal from the cathodes of V15B and V16B is connected directly to the horizontal deflection plates of the cathode ray tube. Since direct coupling is used from the driver tubes to the deflection plates, variation of the static bias of the driver tubes will cause a variation of the average voltage applied to the deflection plates, and hence will effect a change in the average position of the beam. This is accomplished by P8, the HOR POSITION control in the bias circuit of V15A and V16A.

The blanking signal is derived from a positive pulse generated in the cathode circuit of the horizontal multivibrator during the short period when V12B is conducting and discharging the sawtooth capacitor, C36. This signal is coupled to the grid of the blanking generator V14A. Stage V14A is normally held close to cut off because of the high cathode voltage, which is due to the conduction of V14B thru a common cathode resistor.

Diode, CR4, removes any negative going signals at the grid of V14A, but presents a high impedance to positive going signals which drive V14A into conduction. The large negative pulse from the plate of V14A is coupled through blocking capacitor C29 to the grid of the cathode ray tube to cut off the beam during retrace.

DC Circuits

The power supply uses common circuits which are described as follows: A full wave rectifier tube, V24, is used for the minus 150 volt bias supply. Glow discharge tube, V25, provides regulation of this voltage.

A second full wave rectifier, V17, is used to generate the B+ supply voltage. Regulation of the B+ supply is accomplished in the following manner:

A change of the output voltage is coupled to the grid of V19B. That change is cathode coupled to V19A. Since the gride bias of V19A is held constant by glow discharge tube, V21, the change of cathode voltage is amplified in the plate circuit of V19A which is connected to the grid of control tube V20B. V20A holds the cathode of V20B at the correct voltage so that the error voltage at the grid of V20B is amplified. The resulting change at the plate of V20B is coupled to the grids of series regulator tubes V18A and V18B, causing a change in the voltage drop from plate to cathode in such a manner as to correct the original change in output voltage. The B+ supply is set to 370 volts by adjusting the static bias of V19B with potentiometer, P9, the 370 volts ADJ (see figure CRO-6).

The high voltages for the cathode ray tube are generated by half wave rectifier, V22, with some regulation provided by a Victoreen regulator, V23. Since the faceplate of the CRT is operated at ground potential, the electron gun voltages are highly negative (approximately 2500 v). The control grid is slightly more negative than the cathode and is adjustable. Potentiometer, P13, the INTENSITY control on the front panel, controls the grid to cathode bias. The voltage on the accelerator electrode is somewhat positive with respect to the cathode and is adjusted with potentiometer, P10, the FOCUS control. The electrodes connected to pin 9 of the CRT are operated near ground potential. The voltage is adjusted with P11, the ASTIGMATISM control.

MAINTENANCE

Adjustments

The initial adjustments of the CRO waveform monitor have been made at the factory but may require periodic readjustment, especially when tubes or components have been replaced. Refer to the schematic diagram figure CRO-10, and figures CRO-6, CRO-7, and CRO-8 during adjustments.

First Amplifier Operating Point

Connect a VTVM (2.5 volt d-c scale) to test jacks J8 and J9. Adjust P1 for zero volt on the meter with V GAIN switch in the LOW position. Turn V GAIN switch to MED and adjust P15 for zero; switch to HIGH position and adjust P16 for zero. Check voltage again after a half-hour of operation and reset to zero.

Line Voltage

If the line voltage is lower than 111 volts, connect the COMM strap (on terminal board at rear of chassis) to the L terminal. If line voltage is higher than 123 volts, connect the COMM strap to the H terminal.

B+ Adjustment

Connect a VTVM to the B+ bus and ground. Adjust P9 (at rear of chassis) for 370 volts on the VTVM.

Astigmatism

Connect the VTVM between the slider of the astigmatism control, P11, and ground. Adjust P11 for 150 volts on the VTVM. Adjust the FOCUS control for maximum definition of CRO spot. Then readjust P11 for minimum spot distortion. Adjust these two controls alternately to obtain maximum definition with lowest distortion.

Calibration

Calibration of the CRO waveform monitor is required periodically. The following procedure is recommended:

1. Feed a 1-volt peak-to-peak reference signal into the TEST INPUT jack on front panel.

2. Set the VERTICAL input selector switch to VIDEO TEST (external CCW position).

3. Set the V GAIN range switch to MED.

4. Adjust the V GAIN FINE control for a deflection of 140 divisions on the CRO graticule (5 cm).

5. Set the input selector switch to CAL 1.0.

6. Adjust CALIBRATE ADJ. potentiometer, P2, to obtain same deflection as in step 4 above.

Sync Matching

1. With a composite video signal applied to the MON VIDEO INPUT jack, J4, set the front panel SYNC control to dot at the 11 o'clock position.

2. Set S5, EXT-INT switch to INT.

3. Set the V GAIN range switch to MED.

4. Set the 240-V-H sweep selector switch to V and adjust P6 (see figure CRO-8) for a stable two field display.

5. Set the 240-V-H sweep selector switch to H and adjust C24 for a stable two-line display.

6. Place the tape machine in Standby mode.

7. Set the sweep selector switch to 240 and adjust P17 (top-right of chassis facing panel) to lock-in the display.

8. Turn the 240-V-H sweep selector switch to each of its three positions. If display does not lock in without readjustment of SYNC control, repeat the adjustments described in steps 4, 5, 6, and 7.

9. Adjust C36 until the sweep lengths for the H and V positions are equal.

Hum Balancing

1. Disconnect video input cable from J3.

2. Set the input selector switch to VIDEO MON: the V GAIN range switch to HIGH, and the V GAIN FINE control fully clockwise.

3. Adjust the HUM BAL. potentiometer (P14, on top-left side of chassis) for minimum ripple on the CRO trace.

Alignment

This oscilloscope has been factory aligned for maximum flat frequency response. There is associated with this frequency characteristic a response to a step change in voltage. Practically speaking, one seldom experiences the theoretical step change in input because most systems are limited by bandwidth. If the input step is limited to a 10 mc bandwidth, the resulting response should not overshoot by more than 3% when the amplifier is adjusted for a maximum flat frequency response. The tape recorder is limited in response to a bandwidth less than 6 mc.

For complete frequency response alignment of the CRO waveform monitor, perform the following steps:

1. Unsolder the lead of capacitor C9 which is connected to the Frequency Response Selector switch (S2). See figure CRO-7.

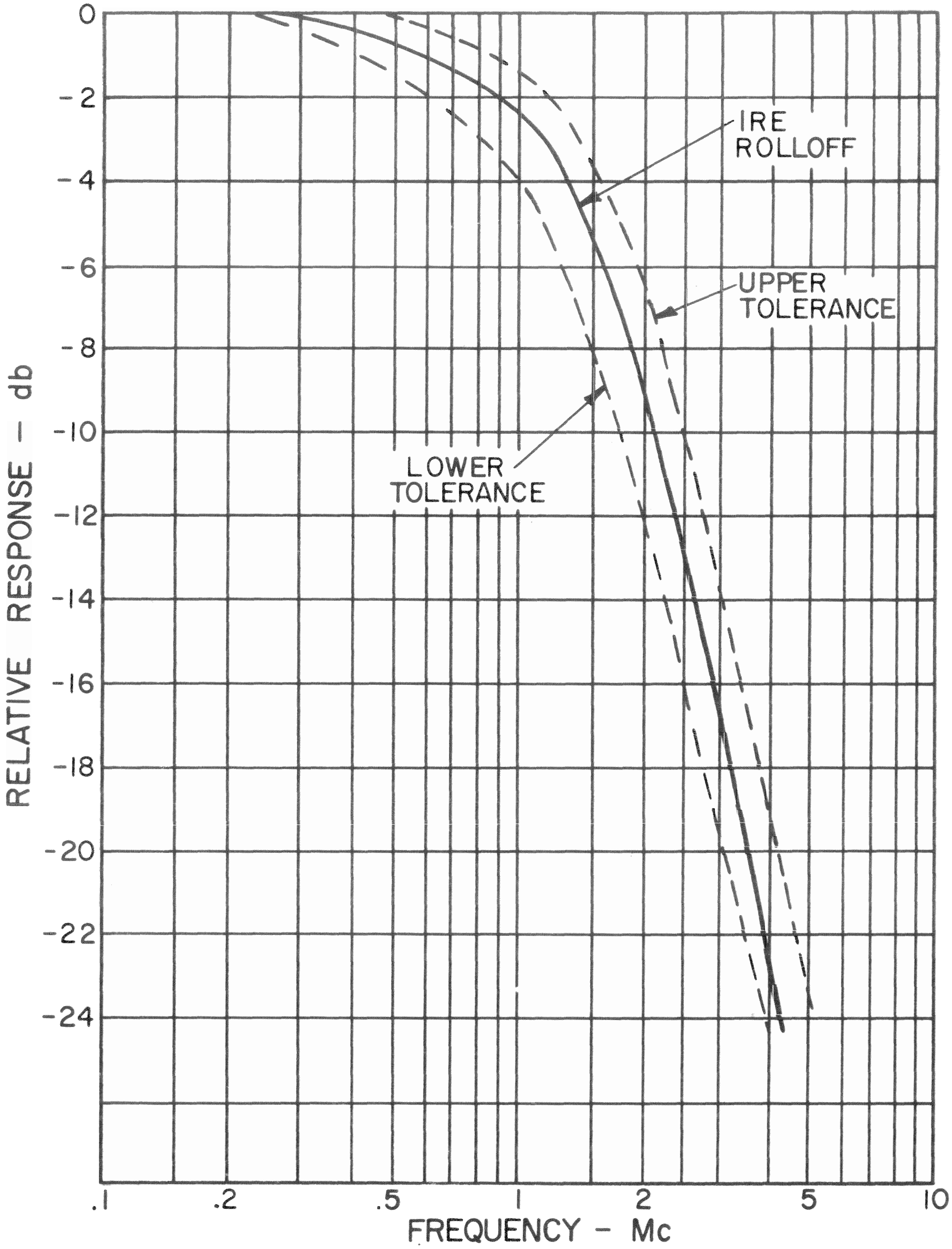


Figure CRO-2. IRE Roll Off Curve

2. With a sweep generator (0–10 mc) feed a signal to the disconnected lead of C9.

3. Remove cable from MON VIDEO INPUT, J3. Set SYNC EXT-INT switch to INT; set 240-V-H sweep speed selector to V; adjust SYNC control for a steady display of the frequency response on the cathode ray tube of the waveform monitor. Adjust H GAIN and H CENT controls so that a single display from 0–10 mc is centered on the screen.

4. Adjust C10 and C13 (plate circuits of V5 and V7) for flattest response to 5 mc with approximately 80 IRE units, deflection on face of monitor.

5. Remove the sweep generator and reconnect C9.

6. Set the frequency response selector switch to DIR, the input selector switch to VIDEO MON, and the V GAIN switch to HIGH.

7. Connect the sweep generator to the MON VIDEO jack, J3, on the rear of the unit and terminate J4 with 75 ohms (or sweep gen. impedance).

8. Adjust the sweep generator output to obtain approximately 80 IRE units deflection and adjust L1 (see figure CRO-7) in the plate circuit of V1A for flattest response to 5 megacycles.

9. Set the V GAIN switch to MED; increase sweep generator output to obtain 80 IRE units deflection, and adjust L3 for flattest response to 5 megacycles.

10. Set the V GAIN switch to LOW; increase sweep generator output to obtain 80 IRE units deflection, and adjust L2 for flattest response to 5 megacycles.

Filter Adjustments

Controls L4, L5, C7 and C51 (in circuit of S2, Freq. Response Selector switch) are adjusted at the factory and should not require adjustment unless a component has been replaced. These controls determine low-pass, high-pass, and IRE filter characteristics.

The controls are interrelated and should be adjusted according to the following procedure:

1. With the sweep connected as in step 6 above and GAIN set to MED, place the Frequency Response Selector Switch to the IRE position. Capacitor, C51 is adjusted for the response specified by the IRE curve shown in figure CRO-2 (down 6 db at 1.5 mc).

2. Place the selector switch in the LP position. Adjust L5 for minimum response at 3.58 mc.

3. Place the selector switch in the HP position. Adjust L4 and C7 so that the output at 1 mc in the HP position is approximately equal to the output obtained at 1 mc in the LP position.

Trouble Shooting

Most troubles can be found by a systematic process of elimination. Waveforms shown in figures CRO-3, CRO-4, and CRO-5 may be used for comparison. A faulty stage can usually be located by checking voltages at the tube sockets against those given in the VOLTAGE CHART (see figure CRO-10). Then the defective part can be isolated by checking voltages directly in the circuits.

The following chart may speed up the identification and correction of trouble:

TROUBLE SHOOTING CHART

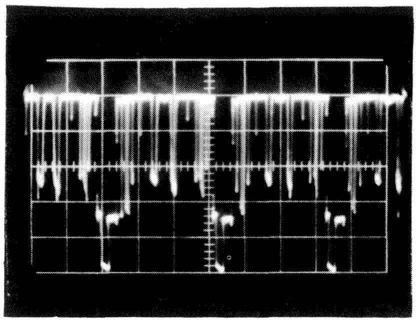
A. No Spot	1. Check V22. 2. Check voltage across C59. 3. Check —150 volt bus and +370 volt bus. 4. Check vertical amplifier balance as follows: Connect a jumper between pin 7 of V3 and pin 7 of V2. Measure plate voltage of V5 and V6. If the circuit is properly balanced the plate voltage will be 150 ±25 volts. 5. Check horizontal amplifier balance as follows: Connect a jumper between pin 8 of V15 and pin 8 of V16. Measure cathode voltage of V15B and V16B. If the circuit is properly balanced the cathode voltage will be 150 ±25 volts.
B. Ripple on Trace (more than 3 millimeters)	1. Adjust hum balance control, P14. 2. Check V1. 3. Adjust P9 or +370 volts on bus. 4. Check ripple on +370 volt bus. 5. Check gas regulator, V21. 6. Check regulator circuits of V18, V19, V20.
C. No Voltage on +370 Volt Bus	1. Check V17, V18, V19, V20, V21.

TROUBLE SHOOTING CHART (Continued)

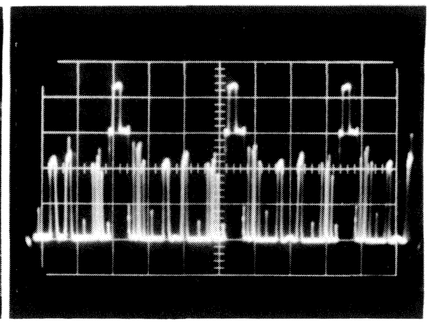
D. Calibration Deflection Varies with Change in Brightness	1. Check V23 as follows. Insert a 0–1 milliammeter in series with the plate lead (between plate and ground). Current should be not less than 25 microamperes at normal intensity and not more than 250 microamperes at minimum intensity (intensity control full counter-clockwise). If current is outside these limits, check R192 and R193.
E. Voltage Variation Across J8-J9 when Gain Selector is Changed	1. Check R158. 2. Check R7.
F. Non-Symmetrical Calibrate Signal	1. Check CR1, CR2.
G. Excessive Brightness Variation along Trace	1. Change V14. Check blanking 2. Check CR4. 3. Check V12.
H. No Sync	1. Check waveforms at terminals of S4. 2. Check V9, V10. 3. Output of V10 should be free of picture information for any input signal from 0.25 volt to 2.0 volts (peak-to-peak). 4. Check screen voltage on V9 (+150 volts). 5. Compare the waveform at pin 2 of V9 with the input signal. No compression should be evident. The signal on the plate (pin 6) of V9 should show some picture information but no sync compression.
I. Color Burst Not Distinguishable in Expanded Position	1. Check for picture signal on pin 1 of V10. No picture information should be visible. 2. Check waveforms at terminals of S4. 3. Check CR3.
J. Short Time Variation of H Centering with H Gain Change	1. Cathode voltage of V13A should be zero volts ±1.5 volts. If not, check R105, R107. 2. Check V13.
K. Vertical Centering Range Inadequate	1. Check V2, V3. 2. Check matching resistors R63, R64, R65, R67, R68. 3. Check R69, R71.
L. Poor Spot Shape—Poor Focus	1. Center spot on CRT and measure voltage on pin 6 of V5, V7, V15 and V16. Mean voltage should be 150 ±15 volts. 2. Check high voltage at "high" side of P13 (should be —2500 volts). 3. Check CRT.
M. Vertical Instability with V Gain Change	Set first amplified operating point as described under *Initial Adjustments.*
N. Low High-Voltage Output	1. Check V22. 2. Check C59.
O. Motor-Boating (Low Frequency Bouncing)	1. Check V2. 2. Check V3.
P. Calibrate Signal Tilt	1. Top-edge tilt—check V5. 2. Bottom-edge tilt—check V7.
Q. Slow Warm-up of Vertical Amplifier	Check matching of R67 and R68. The match should be within 2%.

NOTES:

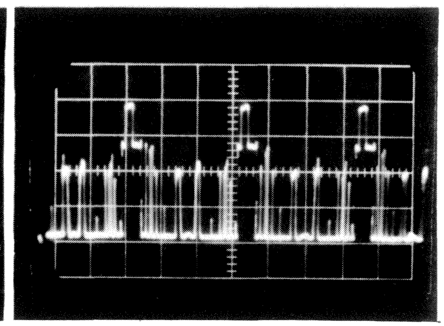
1. Taken with Tektronix Type 535A Oscilloscope.
2. Attenuator Probe (11.5 pf).
3. Switches set as follows: S1-MON, S2-DIR, S3-MED, S4-H, S5-INT.



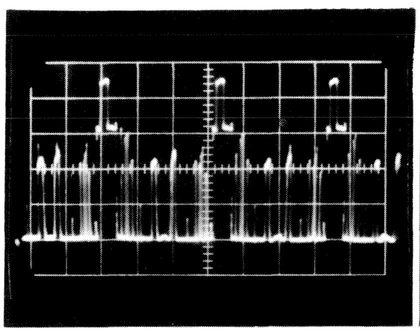
A. J3, VIDEO IN
20 usec/cm, 0.2v/cm



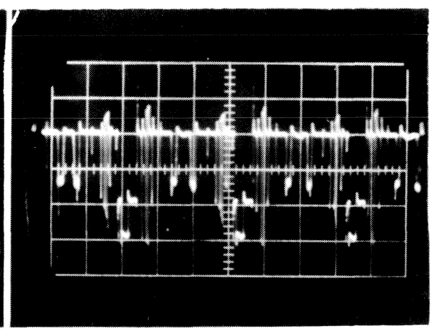
B. V1 pin 9, P-Amp
20 usec/cm, 1v/cm



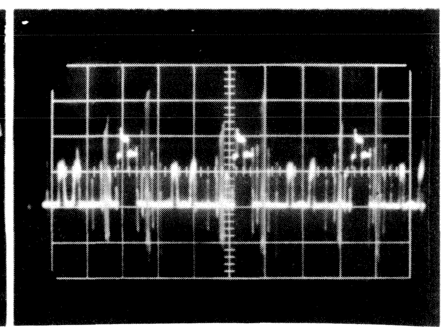
C. V1 pin 1, K-cath fol
20 usec/cm, 1v/cm



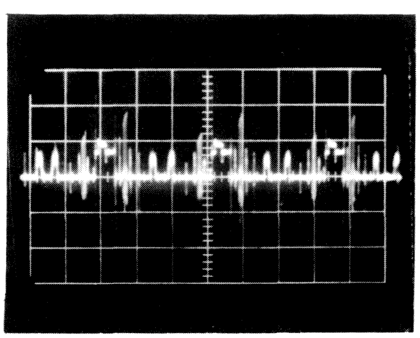
D. V2 pin 7, G-Amp
20 usec/cm, 0.5v/cm



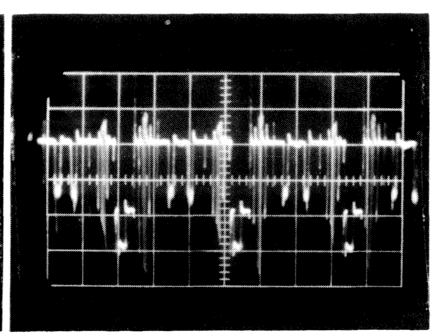
E. V2 pin 9, P-Amp
20 usec/cm, 1v/cm



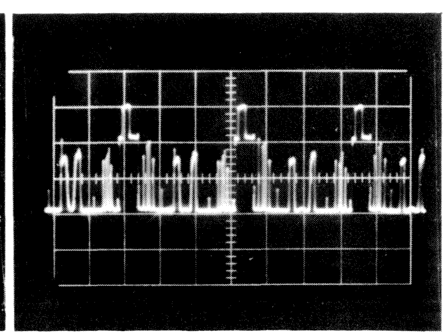
F. V3 pin 9, P-Amp
20 usec/cm, .5v/cm



G. V4 pin 3, K-Driver
20 usec/cm, 1v/cm

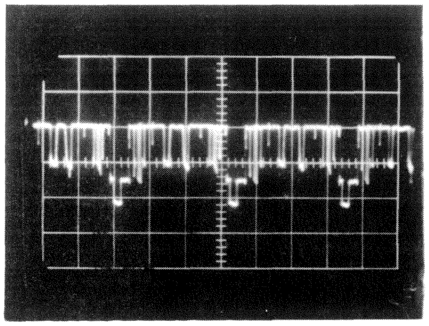


H. V4 pin 8, K-Driver
20 usec/cm, 1v/cm

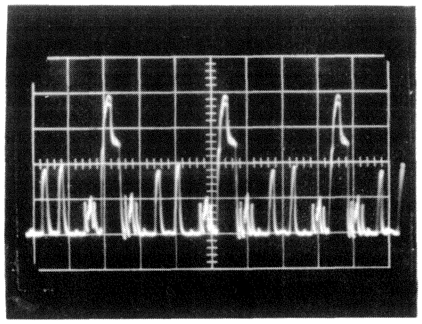


I. V5 pin 6, P-Output
20 usec/cm, 20v/cm

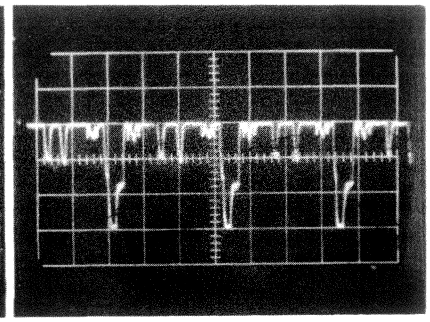
Figure CRO-3. CRO Monitor Waveforms



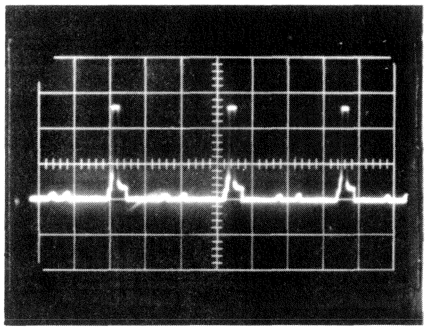
A. V7 pin 6, P-Output
20 usec/cm, 20v/cm



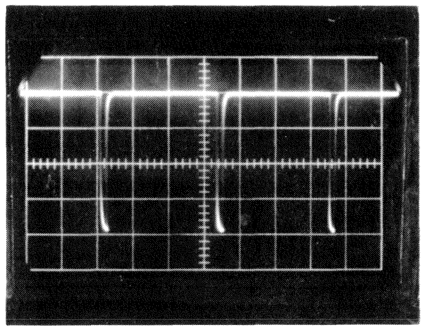
B. J8, Test Jack
20 usec/cm, 1v/cm



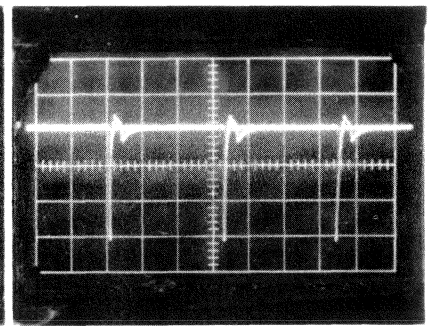
C. V9 pin 6, P-Amp
20 usec/cm, 20v/cm



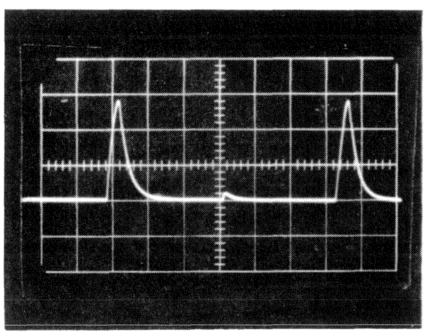
D. V10 pin 6, P-Sync Stripper
20 usec/cm, 2v/cm



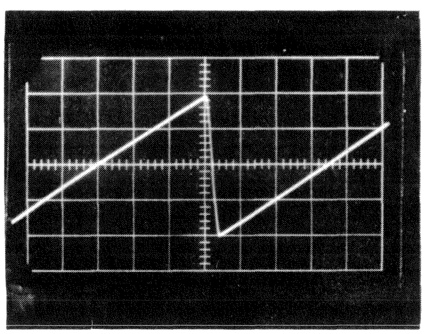
E. V10 pin 1, P-Sync Stripper
20 usec/cm, 1v/cm



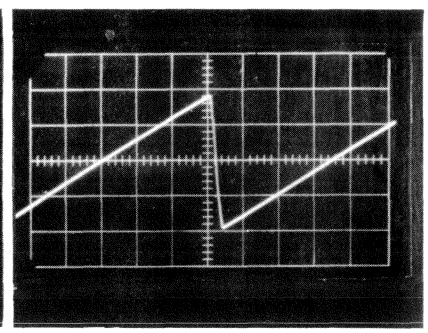
F. V12 pin 2, G-Sawtooth Generator
20 usec/cm, 0.5v/cm



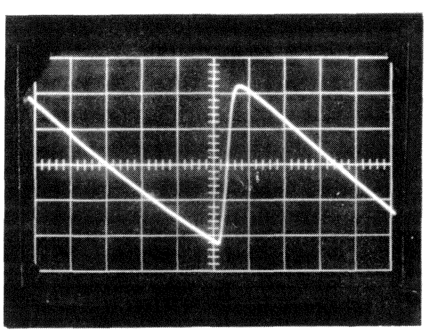
G. V12 pin 1, P-Sawtooth Generator
20 usec/cm, 20v/cm



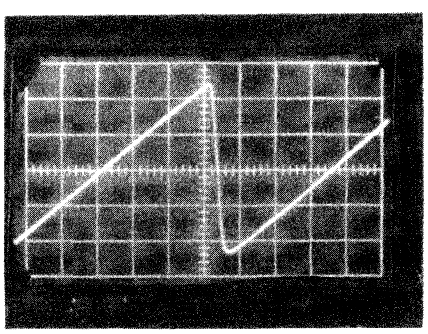
H. V12 pin 6, P-Sawtooth Generator
20 usec/cm, 5v/cm



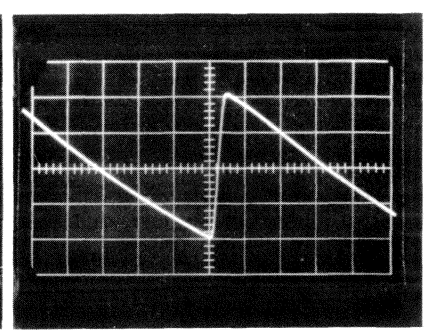
I. V13 pin 3, K-Bootstrap Amp
20 usec/cm, 5v/cm



J. V15 pin 6, P-Driver
20 usec/cm, 20v/cm

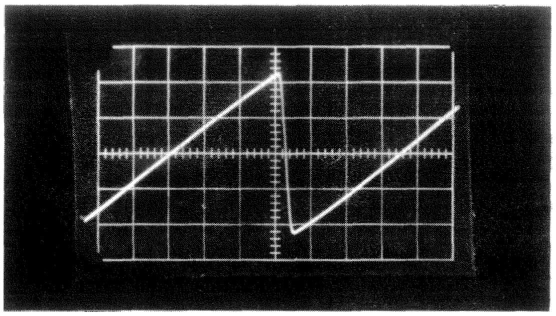


K. V16 pin 6, P-Driver
20 usec/cm, 20v/cm

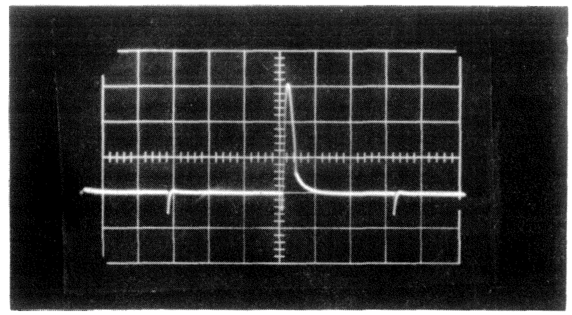


L. V15 pin 3, K-Output
20 usec/cm, 20v/cm

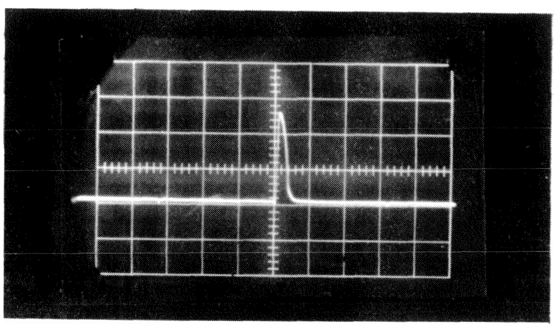
Figure CRO-4. CRO Monitor Waveforms



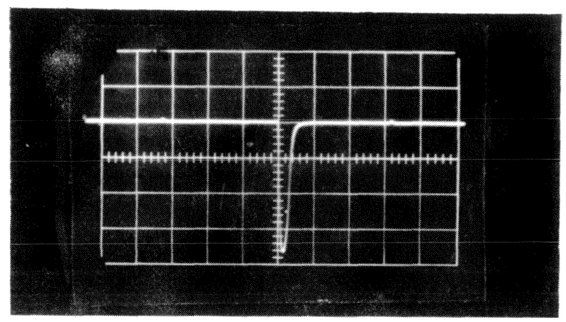
A. V16 pin 3, K-Output
20 usec/cm, 20v/cm



B. V12 pin 8, K-Sawtooth Generator
20 usec/cm, 2v/cm



C. V14 pin 7, G-Blanking
20 usec/cm, 2v/cm



D. V14 pin 6, P-Blanking
20 usec/cm, 20v/cm

Figure CRO-5. CRO Monitor Waveforms

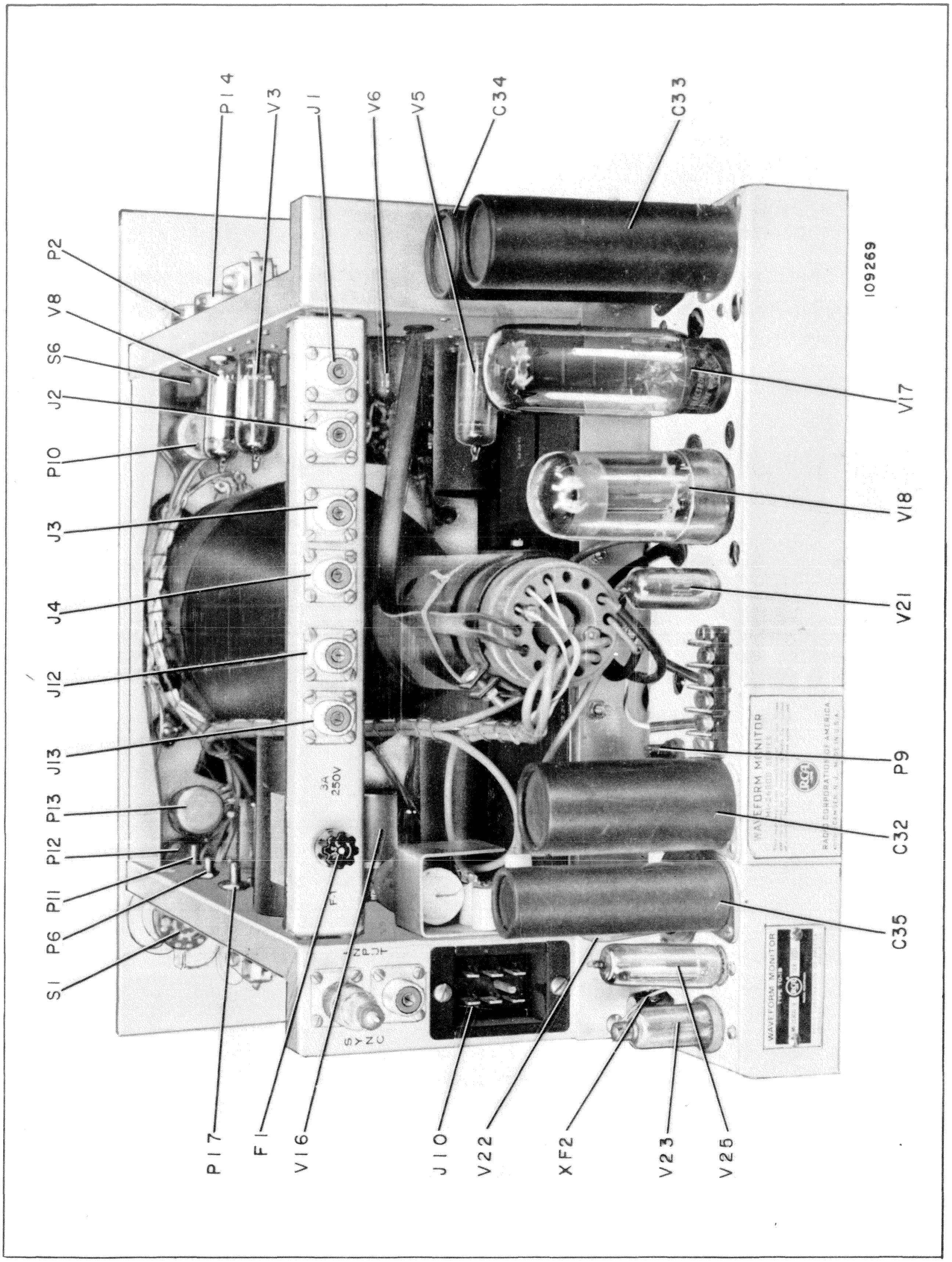


Figure CRO-6. CRO Waveform Monitor, Rear View

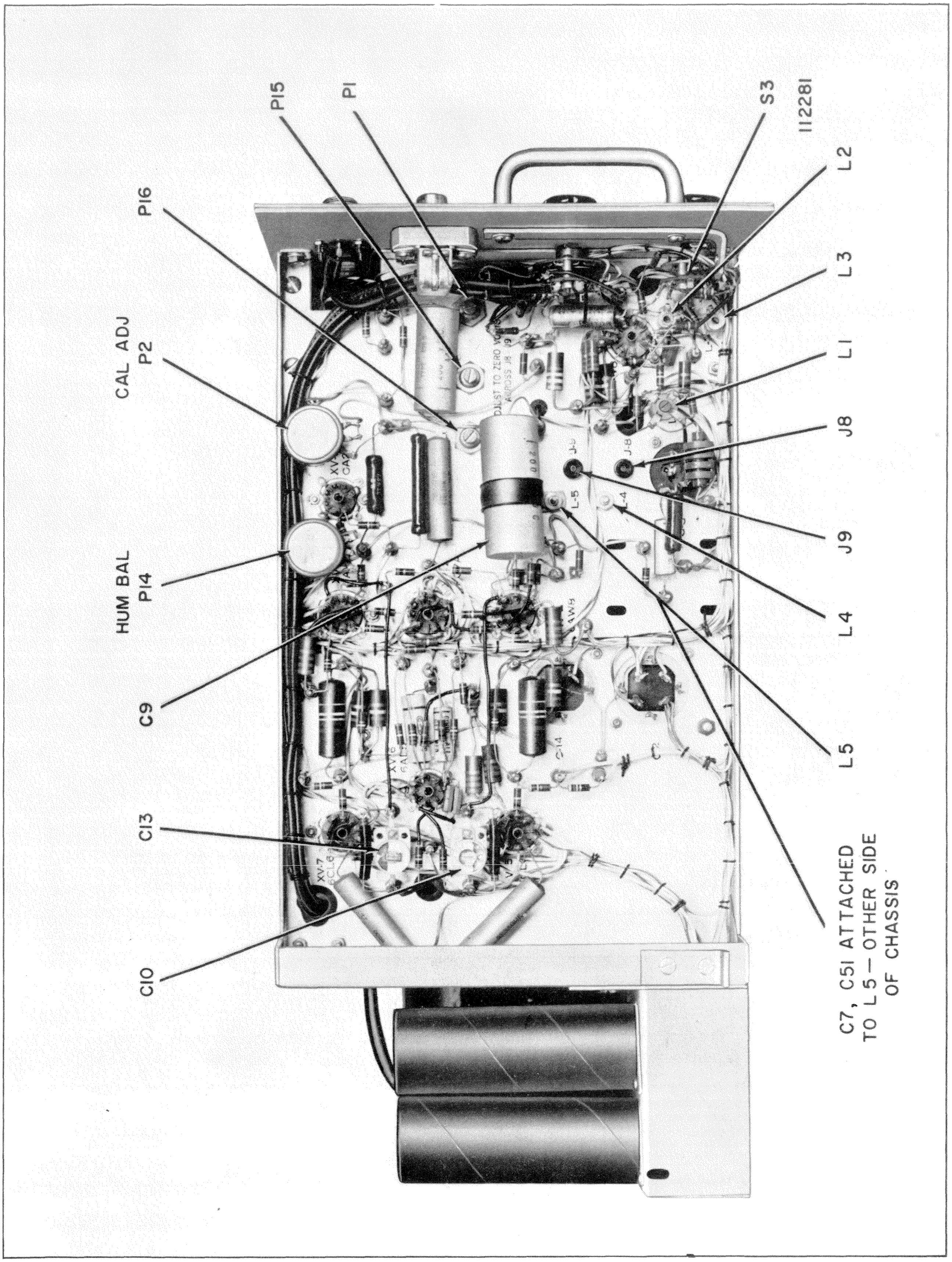


Figure CRO-7. CRO Waveform Monitor, Left Side View

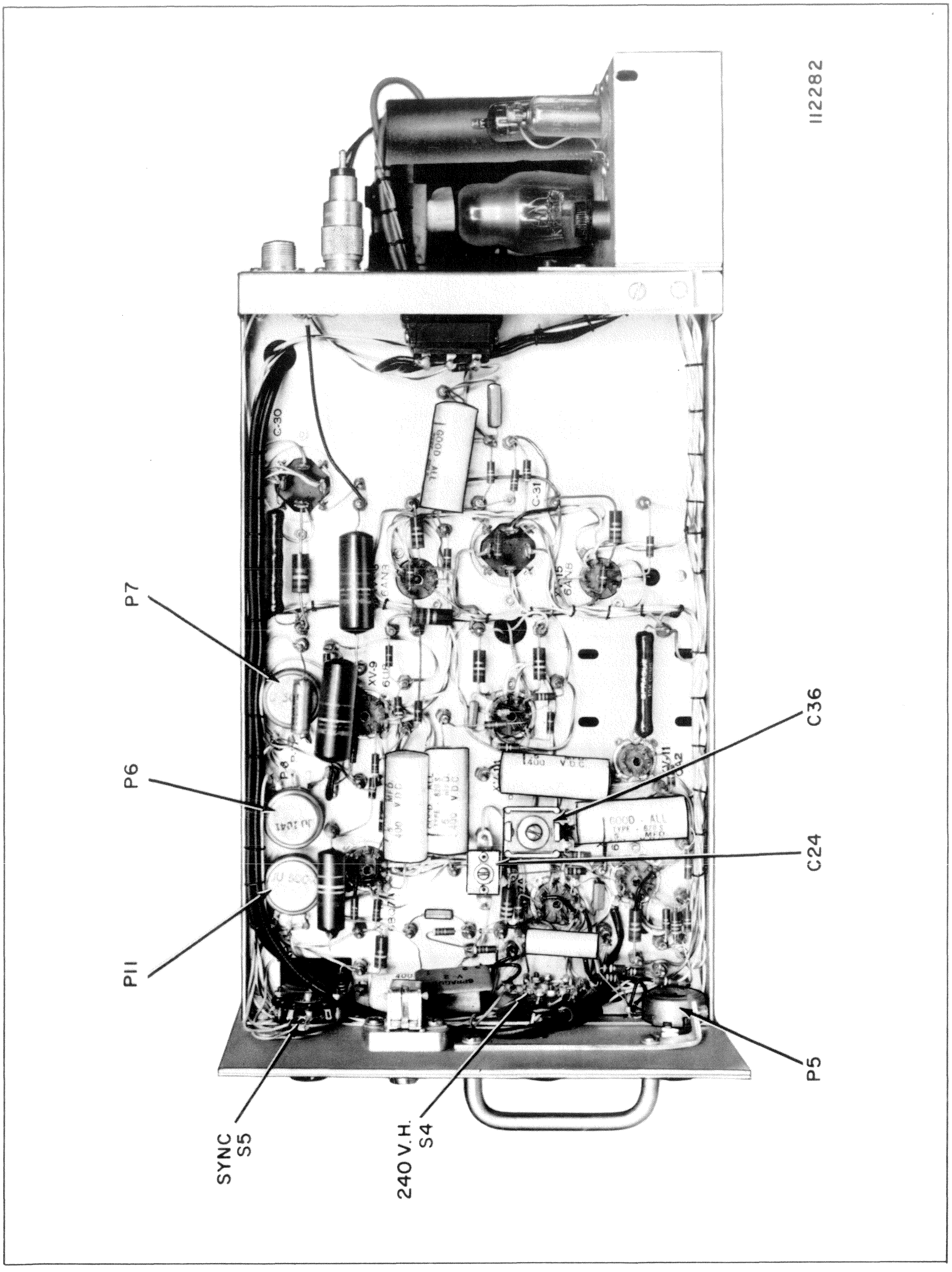


Figure CRO-8. CRO Waveform Monitor, Right Side View

LIST OF PARTS
CRO WAVEFORM MONITOR, MI-26800-B,C

NOTE: All parts the same for the B and C MI Listing except where indicated

Symbol No.	Stock No.	Drawing No.	Description
			CAPACITORS:
C1	213192		paper, 1.0 μf ±20%, 200 v
C2A/D	215044		electrolytic, 80/30/20/20 μf, 250/450 v
C3A/C	213181		electrolytic, 40/20/20 μf, 250 v
C4			Not Used
C5			mica, 390 μμf ±5%, 500 v
C6			Not Used
C7	73075		variable, ceramic, 50-380 μμf
C8	213183		paper, 0.1 μf ±20%, 200 v
C9	213184		paper, 2 μf ±20%, 200 v
C10	56690		variable, ceramic, 1.5-7 μμf, 500 v
C11, C12			paper, 0.1 μf ±10%, 400 v
C13	56690		variable, ceramic, 1.5-7 μμf, 500 v
C14	218925		electrolytic, 250 μf, 200 v
C15	218926		paper, 0.022 μf ±5%, 400 v
C16, C17			Not Used
C18, C19			paper, 0.22 μf ±20%, 200 v
C20			mica, 220 μμf ±5%, 500 v
C21	213185		paper, 0.1 μf ±20%, 400 v
C22	213186		paper, 0.5 μf ±20%, 400 v
C23			mica, 390 μμf ±5%, 500 v
C24	205424		variable, ceramic, 170-780 μμf
C25			paper, 0.1 μf ±10%, 400 v
C26			mica, 390 μμf ±5%, 500 v
C27, C28	213186		paper, 0.5 μf ±20%, 400 v
C29	213187		paper, 0.05 μf ±20%, 3000 v
C30A/C, C31A/C, C32A/C	209307		electrolytic, 20/20/20/20 μf, 450 v
C33A/D, C34A/D	213188		electrolytic, 40/40/30/30 μf, 450 v
C35A/B	213189		electrolytic, 30/20 μf, 350 v
C36	213190		variable, mica, 1150-2605 μμf, 250 v
C37, C38	213182		paper, 0.47 μf ±20%, 200 v
C39	213192		paper, 1.0 μf ±20%, 200 v
C40			mica, 5600 μμf ±5%, 500 v
C41			paper, 0.022 μf ±20%, 400 v
C42			mica, 5600 μμf ±5%, 500 v
C43			paper, 0.1 μf ±10%, 400 v
C44, C45			Not Used
C46			paper, 0.27 μf ±10%, 200 v
C47, C48			mica, 390 μμf ±5%, 500 v
C49			paper, 0.47 μf ±20%, 400 v
C50			mica, 1000 μμf ±10%, 500 v
C51	215036		variable, ceramic, 5-80 μμf
C52			Not Used
C53	215037		paper, 0.1 μf ±20%, 200 v
C54	215038		mica, 11 μμf ±0.5 μμf, 500 v
C55, C56			mica, 20 μμf ±5%, 500 v
C57, C58	215039		paper, 0.047 μf ±20%, 400 v
C59	218927		paper, 0.1 μf ±20%, 4500 v
C60	218928		paper, 0.25 μf ±40 -0%, 3500 v
C61, C only			mica, 100 μμf ±5%, 1500 v char "F"
C62, C only			mica, 1000 μμf ±5%, 500 v char "F"
CR1 to CR4	59395		Rectifier: crystal diode
F1	10907		Fuse: 3 amp. 125 v, slo-blo
F2	53447		Fuse: 1 amp, 125 v, slo-blo
J1 to J7	51800		Connector: female coaxial, chassis mtg.
J8, J9	205675		Connector: tip jack, black
J10	98560		Connector: male, 6 contact, chassis mtg.
J11	51607		Connector: female, 6 contact, chassis mtg.
J12, J13	51800		Connector: female, coaxial, chassis mtg.
L1	210531		Coil: peaking, 18-36 microhenry
L2	213195		Coil: peaking, 15 microhenrys
L3	213196		Coil: peaking, 2.5 microhenry
L4	214859		Coil: peaking, 65-105 microhenry
L5	213198		Coil: peaking, 36-64 microhenry

Symbol No.	Stock No.	Drawing No.	Description
L6	98426		Coil: 2.5 millihenry
L7	215040		Coil: 240 millihenry
L8C only	222629		Coil: 20 microhenry
N1	213199		Printed Circuit: integrater
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
P1	206044		variable, comp., 250,000 ohms, ±10%, 2 w
P2	206045		variable, comp., 5 meg ±20%, 2 w
P3	206913		variable, comp., 1000 ohms, ±10%, 2 w
P4	213200		variable, comp., 500,000/500,000 ohm ±10%, 2 w
P5	95246		variable, comp., 500,000 ohm ±10%, 2 w
P6	95243		variable, comp., 100,000 ohm ±10%, 2 w
P7 to P9	205550		variable, comp., 50,000 ohm ±10%, 2 w
P10	213201		variable, comp., 2.5 meg ±20%, 2 w
P11	95246		variable, comp., 500,000 ohm ±10%, 2 w
P12	213202		variable, comp., 50 ohm ±10%, 2 w
P13	57402		variable, comp., 250,000 ohm, ±20%, 2 w
P14	213515		variable, comp., 100 ohm ±10%, 2 w
P15, P16	206044		variable, comp., 250,000 ohm ±10%, 2 w
P17	94039		variable, comp., 5000 ohm ±10%, 2 w
R1			Not Used
R2			100 ohm ±10%, ½ w
R3			Not Used
R4	213203		275.5 ohm ±1%, ½ w
R5	213204		643 ohm ±1%, ½ w
R6, R7			Not Used
R8	53658		wire wound, 15,000 ohm ±10%, 5 w
R9, R10			Not Used
R11			270 ohm ±5%, ½ w
R12			Not Used
R13			100 ohm ±10%, ½ w
R14			5100 ohm ±10%, ½ w
R15			Not Used
R16			300 ohm ±5%, ½ w
R17, R18			110,000 ohm ±5%, ½ w
R19, R20			100 ohm ±10%, ½ w
R21			1.0 meg ±5%, ½ w
R22			1.5 meg ±5%, ½ w
R23			75,000 ohm ±10%, ½ w
R24			91,000 ohm ±5%, ½ w
R25 to R27			Not Used
R28	96536		wire wound, 8000 ohm ±10%, 10 w
R29			Not Used
R30			100 ohm ±10%, ½ w
R31			2 meg ±5%, ½ w
R32	213205		wire wound, 3500 ohm ±5%, 10 w
R33			100 ohm ±10%, ½ w
R34			6800 ohm ±5%, 2 w
R35			100 ohm ±10%, ½ w
R36, R37			91 ohm ±5%, ½ w
R38			100 ohm ±10%, ½ w
R39			6800 ohm ±5%, 2 w
R40	52975		wire wound, 7500 ohm ±5%, 5 w
R41			100 ohm ±10%, ½ w
R42 to R45			56,000 ohm ±5%, 2 w
R46			100 ohm ±10%, ½ w
R47, R48			Not Used
R49			510,000 ohm ±5%, ½ w
R50			100 ohm ±10%, ½ w
R51, R52			360,000 ohm ±5%, ½ w
R53			510,000 ohm ±5%, ½ w
R54			100 ohm ±10%, ½ w
R55			Not Used
R56			100 ohm ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R57, R58			620 ohm ±5%, 2 w
R59			100 ohm ±10%, ½ w
R60			Not Used
R61, R62			10,000 ohm ±10%, ½ w
R63			680,000 ohm ±5%, ½ w
R64, R65			2.0 meg ohm ±5%, ½ w
R66			680,000 ohm ±5%, ½ w
R67, R68			2.7 meg ±5%, ½ w
R69			22 meg ±10%, ½ w
R70			Not Used
R71			22 meg ±10%, ½ w
R72			1.0 meg ±5%, ½ w
R73, R74			1300 ohm ±5%, ½ w
R75	102241		wire wound, 10,000 ohm ±10%, 10 w
R76			100 ohm ±10%, ½ w
R77			18,000 ohm ±5%, 2 w
R78			4700 ohm ±5%, ½ w
R79			100 ohm ±10%, ½ w
R80			5.1 meg ±5%, ½ w
R81			3.9 meg ±5%, ½ w
R82			3.6 meg ±10%, ½ w
R83, R84			510 ohm ±5%, ½ w
R85			15,000 ohm ±5%, 2 w
R86			100,000 ohm ±10%, ½ w
R87			4700 ohm ±10%, ½ w
R88			100 ohm ±10%, ½ w
R89			33,000 ohm ±5%, 1 w
R90			4700 ohm ±10%, ½ w
R91			680,000 ohm ±5%, ½ w
R92			330,000 ohm ±10%, ½ w
R93			1200 ohm ±5%, ½ w
R94			300,000 ohm ±5%, ½ w
R95			47,000 ohm ±10%, ½ w
R96			150,000 ohm ±5%, ½ w
R97	102241		wire wound, 10,000 ohm ±10%, 10 w
R98			62,000 ohm ±5%, ½ w
R99			33,000 ohm ±5%, ½ w
R100			5100 ohm ±10%, ½ w
R101			24,000 ohm ±10%, ½ w
R102			15,000 ohm ±5%, ½ w
R103			2.2 meg ±10%, ½ w
R104			75,000 ohm ±5%, 1 w
R105			10,000 ohm ±5%, ½ w
R106			360,000 ohm ±5%, ½ w
R107			750 ohm ±10%, ½ w
R108			360,000 ohm ±5%, ½ w
R109			11,000 ohm ±5%, ½ w
R110			2.0 meg ±10%, ½ w
R111			11,000 ohm ±5%, ½ w
R112			1.0 meg ±5%, ½ w
R113			51,000 ohm ±5%, ½ w
R114, R115			100 ohm ±10%, ½ w
R116			2.2 meg ±10%, ½ w
R117			82,000 ohm ±5%, 1 w
R118			22,000 ohm ±5%, 2 w
R119			82,000 ohm ±5%, 1 w
R120			100 ohm ±10%, ½ w
R121, R122			51,000 ohm ±5%, 1 w
R123			100 ohm ±10%, ½ w
R124	213206		wire wound, 2000 ohm ±10%, 3 w
R125	217029		wire wound, 1000 ohm ±10%, 3 w
R126, R127			120,000 ohm ±10%, 1 w

Symbol No.	Stock No.	Drawing No.	Description
R128			180,000 ohm ±5%, ½ w
R129			200,000 ohm ±5%, ½ w
R130	209278		wire wound, 20,000 ohm ±10%, 5 w
R131			240,000 ohm ±5%, ½ w
R132			33 ohm ±5%, 1 w
R133			560 ohm ±10%, ½ w
R134			33 ohm ±5%, 1 w
R135			560 ohm ±10%, ½ w
R136			7500 ohm ±10%, ½ w
R137,R138			Not Used
R139			150,000 ohm ±10%, 2 w
R140			Not Used
R141			10,000 ohm ±10%, ½ w
R142			560,000 ohm ±5%, ½ w
R143			4.7 meg ±5%, ½ w
R144			130,000 ohm ±5%, ½ w
R145			560,000 ohm ±5%, ½ w
R146			150,000 ohm ±5%, ½ w
R147,R148			100 ohm ±10%, ½ w
R149, to R151			Not Used
R152			15,000 ohm ±10%, ½ w
R153			33,000 ohm ±10%, ½ w
R154			2.2 meg ±10%, ½ w
R155,R156			1.8 meg ±10%, 1 w
R157,R158			Not Used
R159			750,000 ohm ±5%, ½ w
R160			Not Used
R161			82,000 ohm ±10%, 1 w
R162			4700 ohm ±10%, ½ w
R163			470,000 ohm ±5%, ½ w
R164			1.0 meg ±5%, ½ w
R165			Not Used
R166			360,000 ohm ±5%, ½ w
R167			1500 ohm ±5%, ½ w
R168			5100 ohm ±10%, ½ w
R169			750,000 ohm ±10%, ½ w
R170			360,000 ohm ±5%, ½ w
R171			150,000 ohm ±5%, ½ w
R172			100,000 ohm ±5%, ½ w
R173			8200 ohm ±5%, 1 w
R174,R175			2700 ohm ±10%, ½ w
R176			1 meg ±5%, ½ w
R177			1.5 meg ±5%, ½ w
R178			750,000 ohm ±5%, ½ w
R179			100,000 ohm ±5%, ½ w
R180			2000 ohm ±5%, 1 w
R181			1200 ohm ±10%, ½ w
R182			1300 ohm ±5%, ½ w
R183			27,000 ohm ±5%, 2 w
R184			2700 ohm ±5%, ½ w
R185			1000 ohm ±5%, ½ w
R186B only			100 ohm ±10%, ½ w
R186C only			470 ohm ±5%, ½ w
R187			2700 ohm ±5%, ½ w
R188	210887		wire wound, 8000 ohm ±5%, 10 w
R189			2700 ohm ±5%, ½ w
R190	210887		wire wound, 8000 ohm ±5%, 10 w
R191			47,000 ohm ±10%, ½ w
R192			680,000 ohm ±5%, 1 w
R193			680,000 ohm ±5%, 1 w
R194			150,000 ohm ±5%, ½ w
R195			390,000 ohm ±5%, 2 w

Symbol No.	Stock No.	Drawing No.	Description
R196			750 ohm ±10%, ½ w
R197			8200 ohm ±10%, 1 w
R198			27,000 ohm ±10%, 2 w
R199C only			1300 ohm, ±5%, ½ w
S1, S2	213208		Switch: rotary, 3 circuit, 1 section, 2-5 position
S3B only	215041		Switch: rotary, 3 circuit, 1 section, 3 position
S3C only	222630		Switch: rotary, 3 circuit, 1 section, 4 position
S4	218929		Switch: 4 circuit, 1 section, 3 position
S5	98239		Switch: rotary, 1 circuit, 1 section, 2 position
S6	59988		Switch: rotary SPST
T1	213211		Transformer: power, low voltage
T2	213212		Transformer: power, hi voltage
V23	213213		Tube: voltage regulating type VXR-2500
V26	213214		Tube: cathode ray, type 5AQP1
			Miscallaneous:
	211429		Catch: cabinet, push button type, without spring
	210862		Clamp: cable, black nylon
	213223		Coupling: flexible, insulated
	213221		Coupling: resistor
	213224		Cover: capacitor, insulating 1" ID x 4" ht.
	206007		Cover: capacitor, insulating, 1.46" ID x 4.063 ht.
	213218		Cushion: rubber, bezel shock mtg.
	213215		Escutcheon: front panel overlay
	213275		Extension: bushing, brass
	213220		Filter: light green, part of bezel
	205914		Holder: fuse
	213228		Insulator: ceramic pillar, ½ dia. x 3/4 ht., #6-32 tapped hole
	211347		Jewel: pilot light, red
	30075		Knob: control, pointer type, 1" dia.
	205329		Knob: control, pointer type, 3/4" dia.
	94863		Lamp: pilot, 6 v, 0.2 amp
	213222		Light: bezel, edge window lighting including lamps
	213219		Nut: thumb, bezel adjustment
	213216		Shield: magnetic, cathode ray tube
	56359		Shield: tube, for noval sockets
	210554		Socket: pilot light
	54414		Socket: tube octal
	65451		Socket: tube, 4 contact, hi voltage
	213225		Socket: tube, 14 contact
	94925		Socket: tube, 7 pin miniature
	213226		Socket: tube, 7 pin miniature, hi voltage
	94926		Socket: tube, 9 pin miniature
	94880		Socket: tube, 9 pin with shielded base
	213227		Terminal: stand-off
	213217		Window: bezel, special engraved scale

NOTES

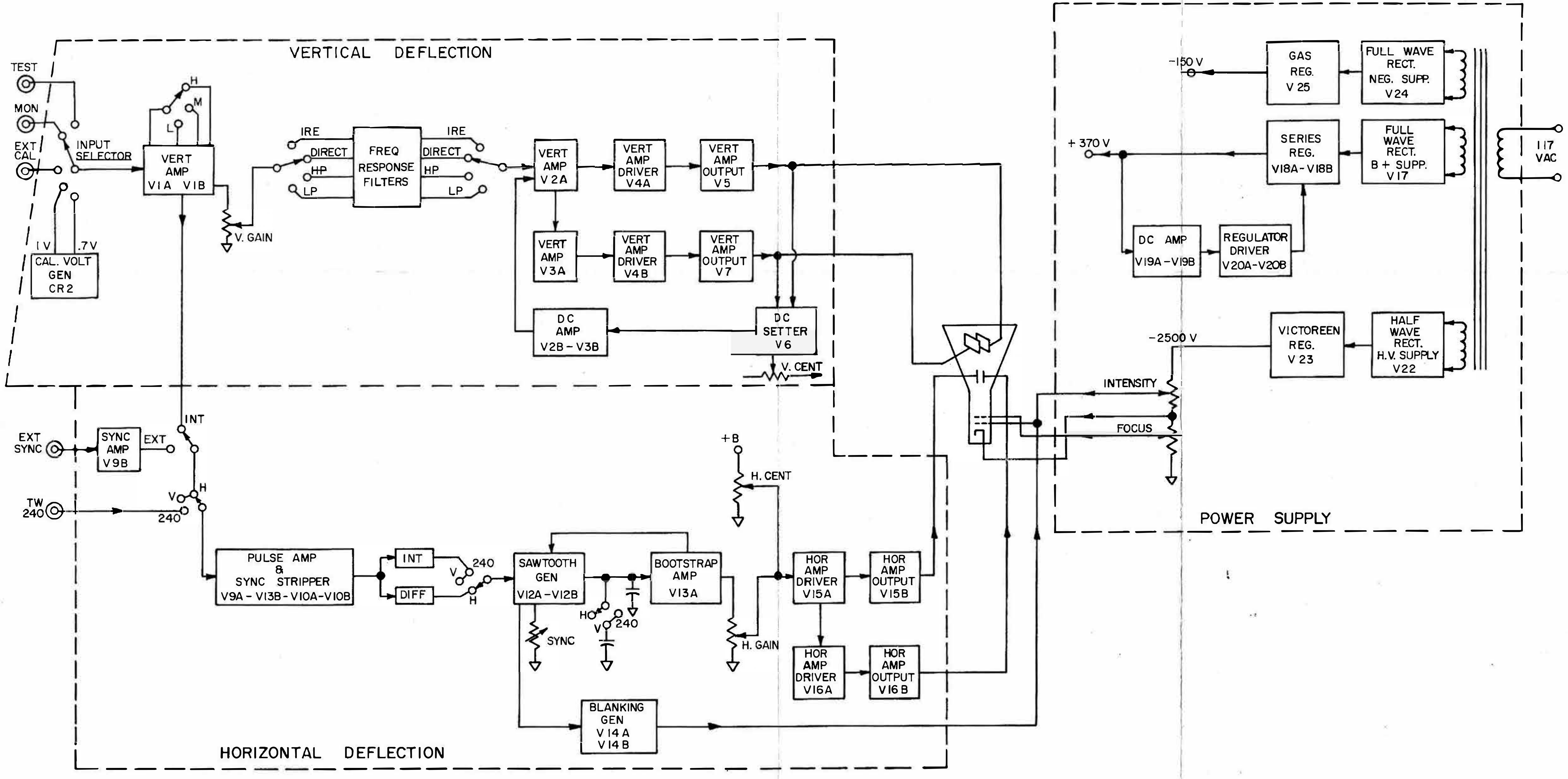


Figure CRO-9. CRO Waveform Monitor, Block Diagram

VOLTAGE CHART

NOTES: 1. Vertical gain switch set at medium.
2. Normal video signal displayed on screen.
3. Voltages recorded on Simpson Model #269 meter.
4. Line Input—115 volts AC.

Symbol	*Tube Type*	*Socket Pins*								
		1	2	3	4	5	6	7	8	9
POWER SUPPLY										
V17	5U4GB	—	460	—	457VAC	—	457VAC	—	460	—
V24	6X4*	190AC	—	—	—	—	190AC	212	—	—
V25	OA2*	—	—	—	—	150	—	0	—	—
V18	6080	355	460	375	355	460	375	—	—	—
V21	5651	86	—	—	—	—	—	—	—	—
V19	12AX7	370	87	88	—	—	204	87	88	—
V20	6AN8	370	201	202	—	—	364	370	201	202
SYNC										
V9	608	185	—5	150	—	—	148	0	4	0
V10	6BQ7A	215	105	150	—	—	210	150	151	—
HORIZONTAL										
V13	6BQ7A	220	—.4	0	—	—	103	103	148	—
V12	6BQ7A	240	0	5	—	—	26	—15	5	—
V14	6BQ7A	180	70	73	—	—	185	70	73	Vert. Sweep
V11	OA2	150	0	—	—	—	—	—	—	—
V15	6AN8	370	140	152	—	—	140	146	1.5	8.5
V16	6AN8	370	134	145	—	—	134	148	1.5	8.5
VERTICAL										
V1	6AU8	140	140	333	—	—	4.5	2	145	140
V2	6AW8	150	149	245	—	—	145	140	315	245
V3	6AW8	150	149	315	—	—	148	145	315	265
V4	6BQ7A	370	264	265	—	—	370	250	249	0
V5	6CL6	21	17.5	142	—	—	160	21	142	—
V7	6CL6	21	18.5	142	—	—	150	21	142	—
V6	6AL5	146	160	—	—	180	—	125	—	—
V8	OA2	150	0	—	—	—	—	—	—	—

* Measured from —150 Source.

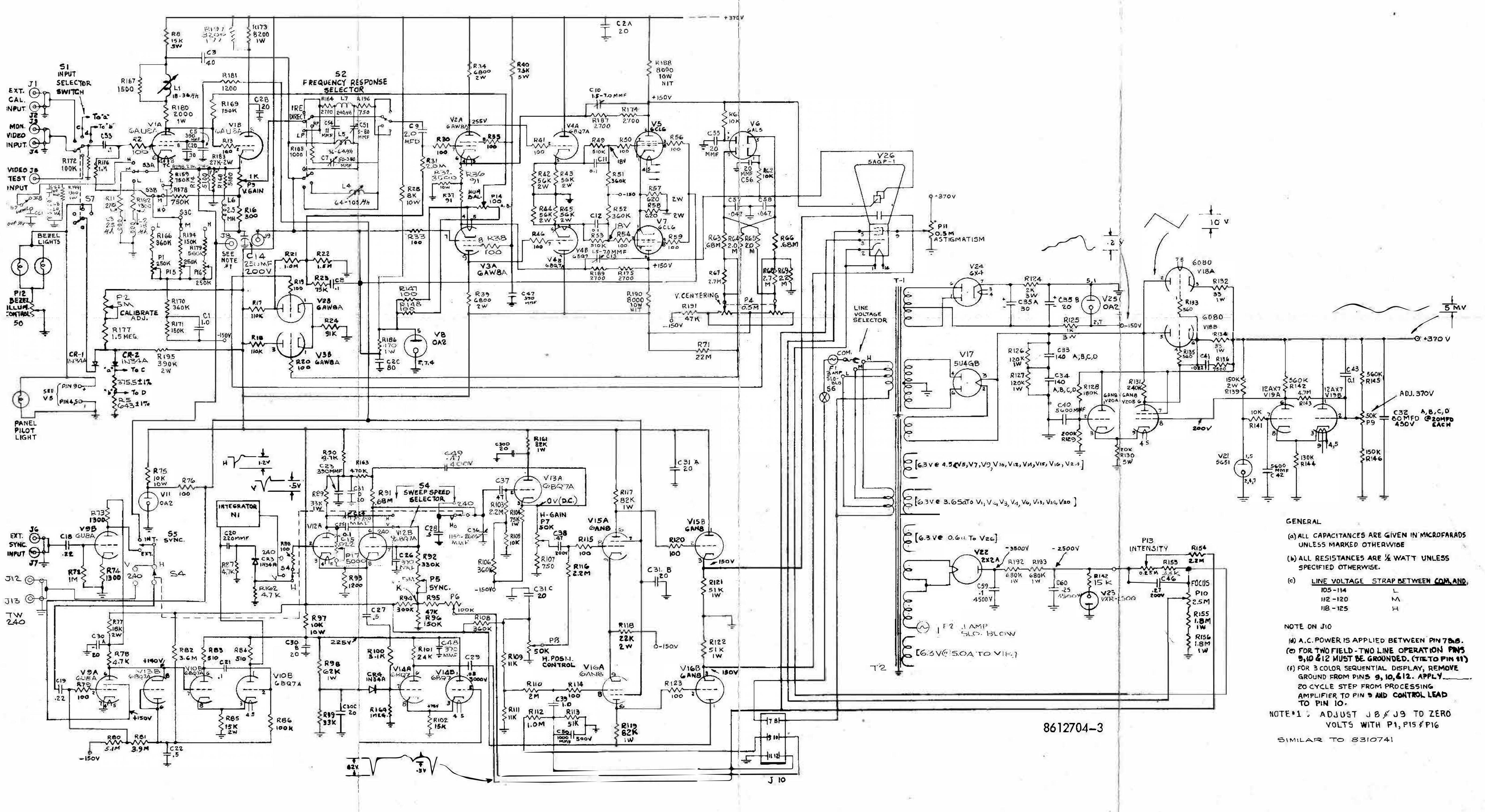


Figure CRO-10. CRO Waveform Monitor, Schematic Diagram

ELECTRONIC RECORDING PRODUCTS

CRO/Monitor Switcher

UNIT 307

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 641

IB-31144

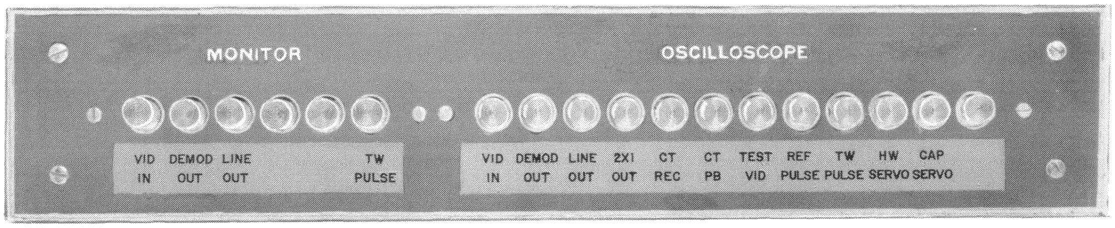


Figure CMS-1. CRO/Monitor Switcher

DESCRIPTION

CRO/Monitor Switcher, unit 307, Figure CMS-1, is a pushbutton panel mounted beneath the Cathode Ray Oscilloscope (CRO) in rack number 3. It provides a convenient means of selecting the various signals for display on the CRO and picture monitors for performance evaluation while operating the tape recorder. The switcher consists primarily of two pushbutton switch assemblies, one for the OSCILLOSCOPE (12 pushbuttons) and one for the MONITOR (6 pushbuttons). When the pushbuttons are not depressed they are terminated in their proper resistance so that no transients will be fed out on the program line when switching occurs.

Oscilloscope

The pushbuttons under OSCILLOSCOPE select the desired waveform to be viewed on the Cathode Ray Oscilloscope (CRO). In order to ascertain if the selected waveform is correct compare it with the appropriate waveform.

Monitor

The pushbuttons under MONITOR select the desired information to be displayed on the television picture monitor (unit 103). When the pushbutton labeled TW PULSE is pressed white dots will appear on the raster instead of a picture.

MAINTENANCE

Cleaning

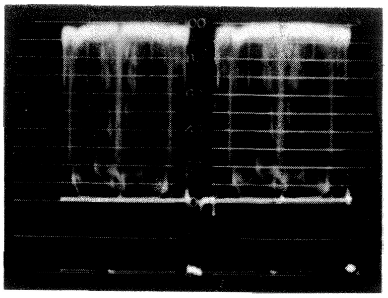
The switches of the CRO/Monitor Switcher should be cleaned periodically.

OSCILLOSCOPE

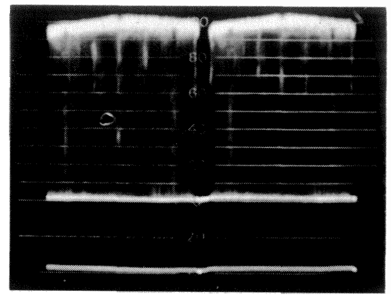
Pushbutton	*Originating Chassis*
VID IN	Input Video signal from Distribution Amplifier #1.
DEMOD OUT	Demodulator output signal from Distribution Amplifier #2.
LINE OUT	Video output signal from Signal Processing Amplifier.
2X1 OUT	FM output signal from 2X1 Switcher.
CT REC	Control track video head current during record.
CT PB	Control track video head current during play.
TEST VID	Output signals from station color bar generator.
REF PULSE	60 cycle output signal from reference generator.
TW PULSE	240 cycle output signal from Tone Wheel Amplifier.
HW SERVO	Head Wheel Servo trapezoid generator output TP8.
CAP SERVO	Capstan Servo sawtooth generator output.

MONITOR

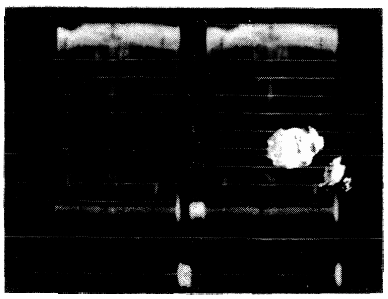
Pushbutton	*Originating Chassis*
VID IN	Input video signal from Distribution Amplifier #1.
DEMOD OUT	Demodulator output signal from Distribution Amplifier #2.
LINE OUT	Video output signal from Signal Processing Amplifier.
TW PULSE	240 cycle output signal from Tone Wheel Amplifier (white dots on raster).



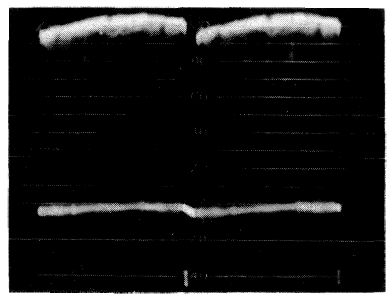
VID IN
(Horiz. Rate)



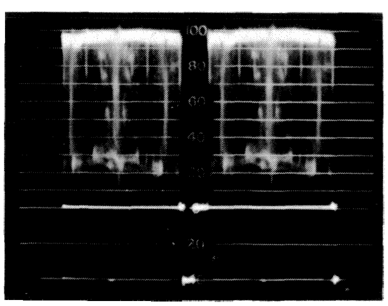
VID IN
(Vert. Rate)



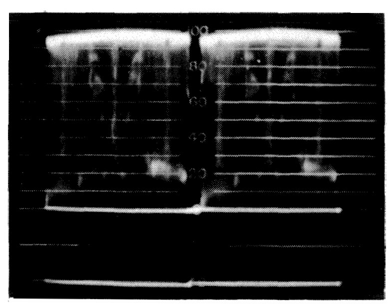
DEMOD OUT
(Horiz. Rate)



DEMOD OUT
(Vert. Rate)

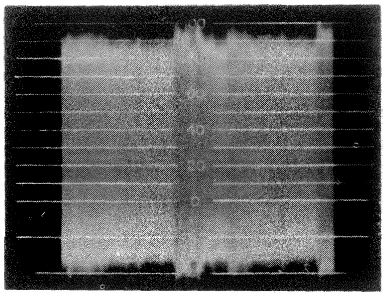


LINE OUT
(Horiz. Rate)

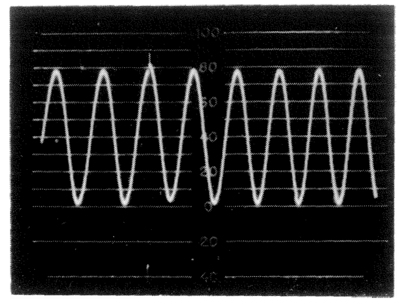


LINE OUT
(Vert. Rate)

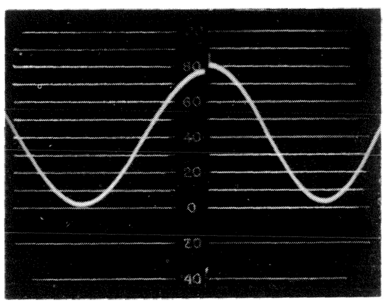
Figure CMS-2. Waveforms Displayed on CRO Monitor



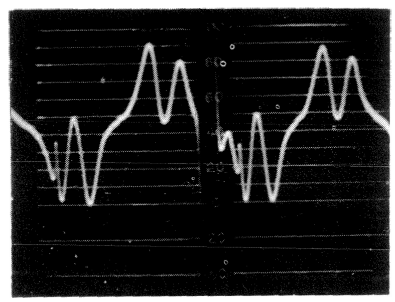
2 X 1 OUT
(240 Rate)



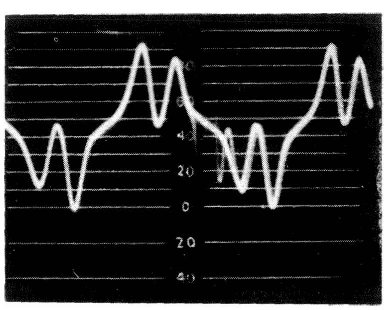
CT REC
(Vert. Rate)



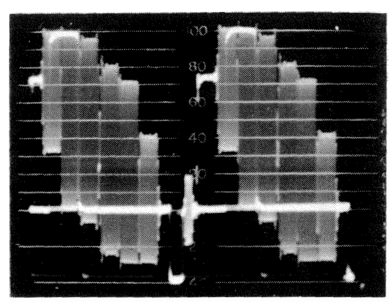
CT REC
(Expanded)



CT PB
(Playback)

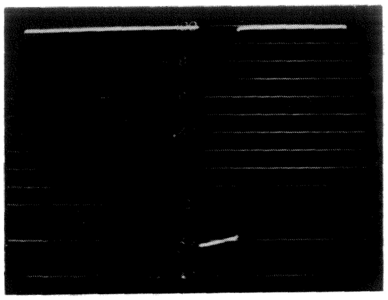


CT PB
(Simul. Playback-Record)

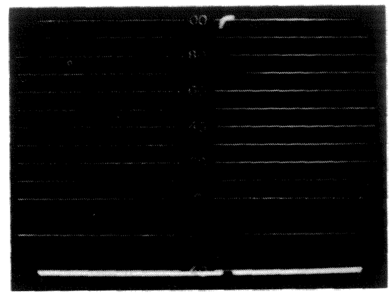


TEST VID

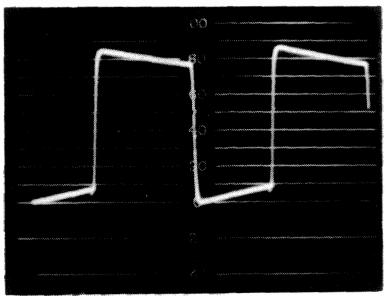
Figure CMS-3. Waveforms Displayed on CRO Monitor



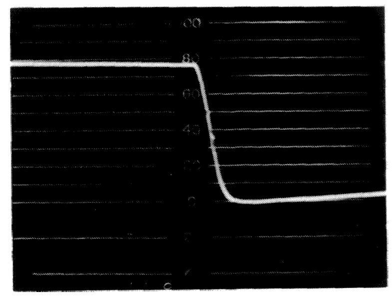
REF PULSE
(240 Expanded)



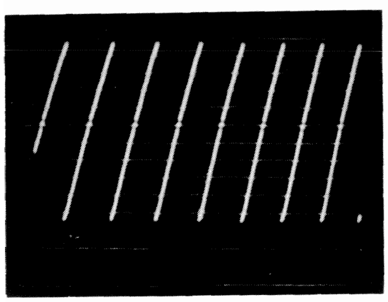
TW PULSE
(240 Expanded)



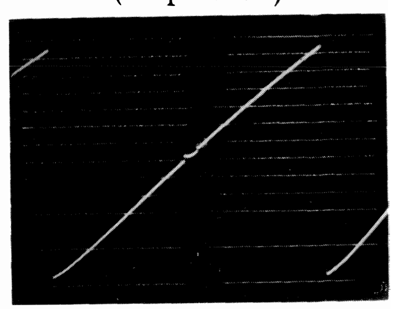
HW SERVO
(240 Rate)



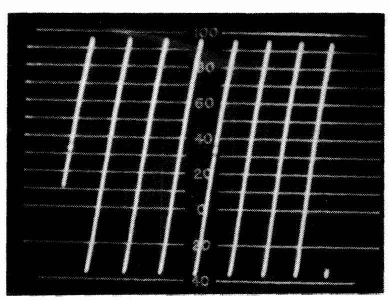
HW SERVO
(Expanded)



CAP SERVO
(Vert. Rate-Playback)



CAP SERVO
(Expanded-Record)

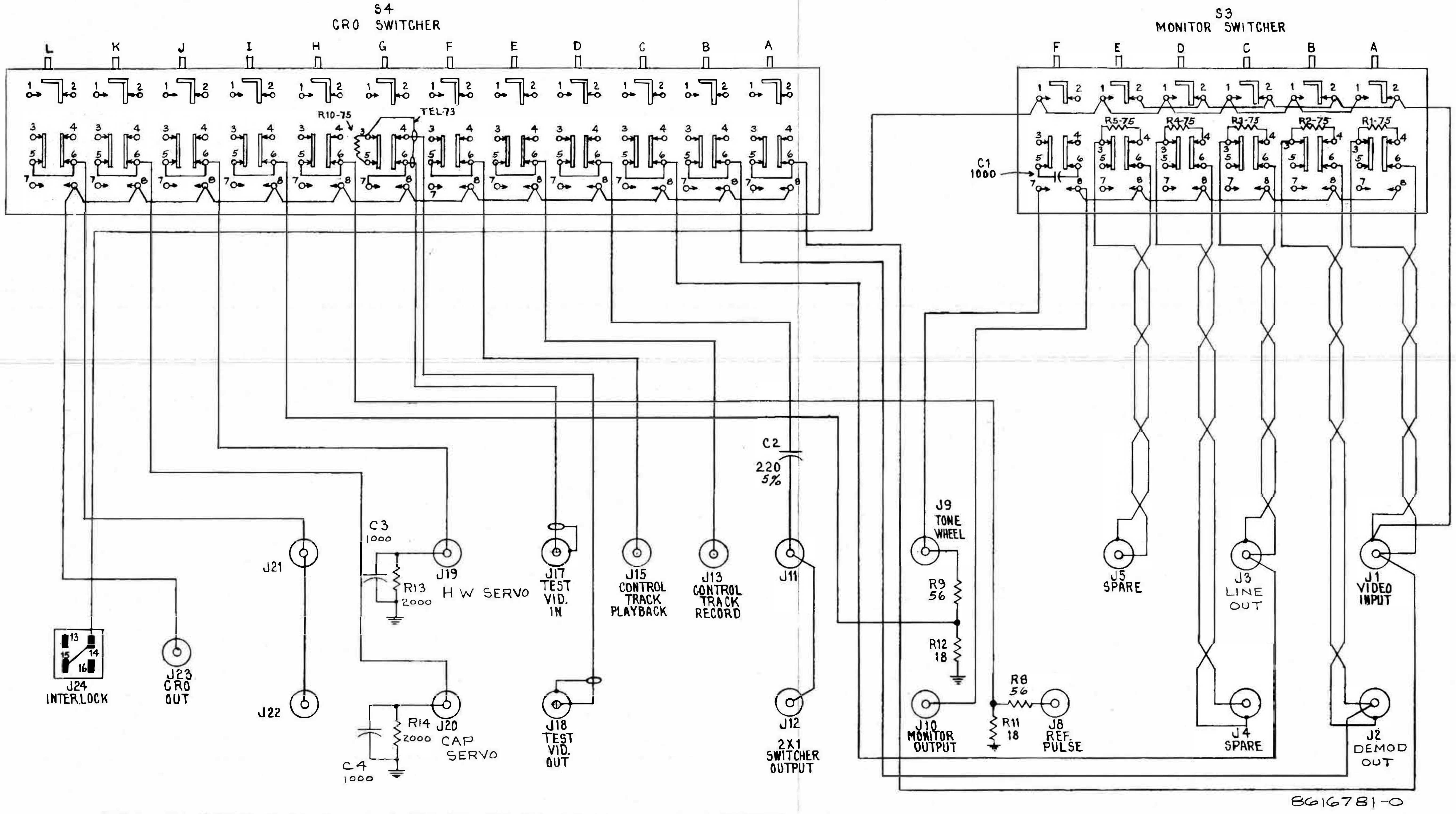


CAP SERVO
(Vert. Rate-Record)

Figure CMS-4. Waveforms Displayed on CRO Monitor

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			CRO MONITOR SWITCHER (8974467-503) 7
C1		727866-147	Capacitor: mica, 1000 $\mu\mu$f ±10%, 500 v char "B"
C2		8914319-332	Capacitor: mica, 220 $\mu\mu$f ±5%, 500 v char "F"
C3 & C4		881182-7	Capacitor: ceramic, 1000 $\mu\mu$f +100 -20%, 500 v
J1 to J5	51800	255223-2	Connector: coax, chassis mtg.
J6, J7			Not Used
J8 to J13	51800	255223-2	Connector: coax, chassis mtg.
J14			Not Used
J15	51800	255223-2	Connector: coax, chassis mtg.
J16			Not Used
J17 to J23	51800	255223-2	Connector: coax, chassis mtg.
J24	52107	727969-13	Connector: male, 4 contact
P1, P2	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter: solder type
P3 to P7			Not Used
P8	215661	252868-1	Connector: coax, cable mtg.
P9 to P12	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter: solder type
P13	215661	252868-1	Connector: coax, cable mtg.
P14			Not Used
P15	215661	252868-1	Connector: coax, cable mtg.
P16			Not Used
P17	215661	252868-1	Connector: coax, cable mtg.
P18	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter: solder type
P19, P20	215661	252868-1	Connector: coax, cable mtg.
P21, P22			Not Used
P23	215661	252868-1	Connector: coax, cable mtg.
	54246	893648-2	Adapter: solder type
P24	52108	727969-14	Connector: female, 4 contact
R1 to R5		82283-132	Resistor: fixed, comp., 75 ohm ±5%, ½ w
R6, R7			Not Used
R8, R9		82283-129	Resistor: fixed, comp., 56 ohm ±5%, ½ w
R10		82283-132	Resistor: fixed, comp., 75 ohm ±5%, ½ w
R11, R12		82283-117	Resistor: fixed, comp., 18 ohm ±5%, ½ w
R13, R14		82283-166	Resistor: fixed, comp., 2000 ohm ±5%, ½ w
S1, S2			Not Used
S3	219525	8723780-2	Switch: pushbutton, 6 position
S4	219524	8723780-1	Switch: pushbutton, 12 position
			Miscellaneous:
	204081	470691-501	Pushbutton: clear plastic for S3 and S4



NOTE 1. ALL RESISTOR VALUES IN OHMS-½WATT-5% AND ALL CAPACITORS IN MICRO-MICROFARADS UNLESS OTHERWISE SPECIFIED.

NOTE 2. USE PT. NO. 37, .032 DIA. BUS AND PT. NO. 32, .042 I D SLEEVING FOR ALL WIRES TO CRO AND MONITOR SWITCHES, EXCEPT WHERE TWISTED PAIRS ARE SHOWN. RUN WIRES AS DIRECT AS POSSIBLE AND SEPARATED.

NOTE 3 DO NOT CABLE WIRES. RUN EACH TWISTED PAIR SEPARATE.

WIRE TABLE	
CRO SW	MON. SW.
.032 DIA. BUS	WHT-GRN 7/010
.042 I D SLEEVING	WHT-BLK 7/010
TEL-73 COAX.	GROUND
	.032 DIA. BUS
	.042 ID SLEEVING

Figure CMS-5. CRO Monitor Switcher Schematic Diagram

ELECTRONIC RECORDING PRODUCTS

Signal Processing Amplifier

UNIT 308

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
GO 681

IB-31145

LIST OF ILLUSTRATIONS

109204

Figure SPA-1. Signal Processing Amplifier (for Color System)

109206

Figure SPA-2. Signal Processing Amplifier (for Monochrome System)

TECHNICAL DATA

Power Required

117 V 60 cycles AC   C.B. #2
20 watts

Inputs

Video: 1 v p-p nominal
Color: 1 v p-p nominal
Sep. Sync: 4 v p-p nominal
3.58 mc: 2 v p-p nominal

Outputs

Video Out #1: 1 v p-p nominal (composite or non-composite)
Video Out #2: 1 v p-p nominal
Video Out #3: 1 v p-p nominal
Regenerated Sync: 4 v p-p nominal
Horizontal Drive: 4 v p-p nominal

Fuses

11F1 1 amp
11F2 0.5 amp
11F3 0.75 amp

Transistor and Diode Complement

Qty.	*Transistor*	*Qty.*	*Diode*
Monochrome System			
28	2N404	18	1N100
18	2N1090	7	1N2069
13	2N1301	4	1N54A
4	2N1183	2	1N608
3	2N1143	2	1N2071
2	2N1091	1	5V3170
1	2N1417	1	650C
1	2N595		
1	2N332		
1	2N301		
Color System			
7	2N1301	2	8983872-1
6	2N1224	1	1N538
3	2N1090	1	1N100

DESCRIPTION

Introduction

The Signal Processing Amplifier serves as a "revitalizing center" for the synchronized elements of the composite video signal, to assure the system output of a standard video signal suitable for transmission. The video signal is clamped to set the proper DC level, new blanking is added accurately and old sync is removed and new added. When a color signal is present, the old burst is removed and new burst is added. When the video signal enters the processing amplifier, the sync pulses may be deformed, with noise spikes and switching disturbances during the blanking interval. Integration of the processing amplifier into the system provides an outgoing video signal with a clean and adjustable black level and a clean horizontal-sync interval. The amplifier completely regenerates horizontal sync, regenerates horizontal and vertical blanking and reinserts the vertical interval. The clean horizontal interval eliminates misclamping, in transmitter and stabilizing amplifiers, which tends to occur because of the noise in the area below black level.

All of the modules are transistor units with new circuitry which contributes greatly to the overall stability and provides a means for accuracy and fast, automatic recovery of vertical-blanking regenerating circuits. Horizontal and vertical pulse-advance techniques, pulse-narrowing circuits, regulator circuits and multivibrators are all special features of this device and are discussed in full where most applicable for each module. Block diagrams are provided for each module; a series of waveforms keyed to simplified schematics are included with the description of each module (except the Power 1 and Power 2 Modules). Photographs with callouts and a complete schematic for each module are also included with this instruction book.

Overall Physical Description

As shown in figure SPA-1, the Signal Processing Amplifier consists of a standard 19-inch wide, rack-mounting frame, only 5¼ inches high, in which the following eight plug-in modules are installed:

Input and Blanking	Vertical Advance
Output	Sync Logic
*Color	Power 1
Horizontal AFC	Power 2

The frame mounts eight, 24-terminal connectors which engage the matching pin connectors at the rear of each module. As shown in figure SPA-3, two brackets, mounted at an angle to the rear apron, provide a convenient mounting area for the AC power receptacle and twelve coaxial connectors. Refer to the Connector Chart. Relay K1 is mounted on the frame between the brackets, adjacent to an unused connector aperture, and provides a means of switching signal paths for monochrome or color operation. The width of the module varies; four of the modules are one unit wide (1⅜ inches) and four are two units wide (2¾ inches).

* As shown in figure SPA-2, when the TRT system is a monochrome system, a blank panel is inserted to preserve uniformity.

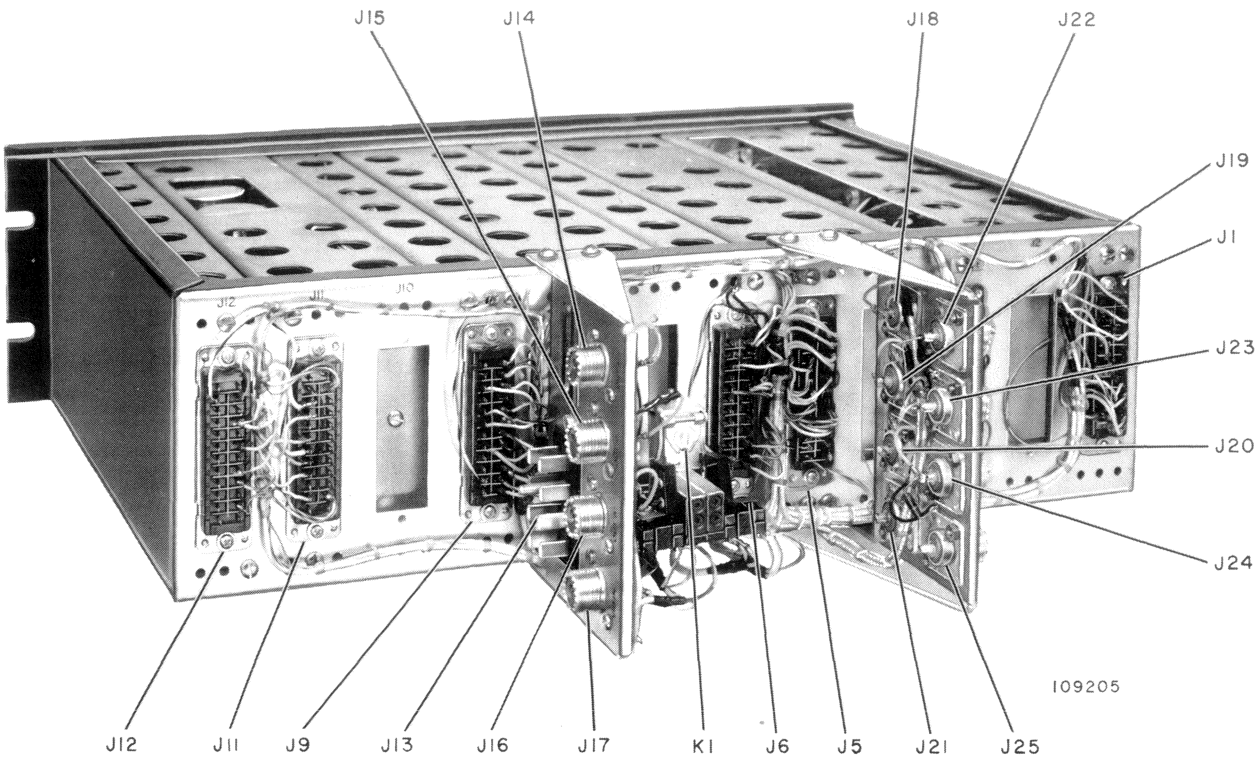


Figure SPA-3. Signal Processing Amplifier Rear View

CONNECTOR CHART

Connector	*Designation*	*Module Interconnection*
J13	POWER	AC Power Plug (See Frame Schematic Figure SPA-45)
J14	OUT #1	Output Module Output #1 3J3-7
J15	OUT #2	Output Module Output #2 3J3-10
J16	OUT #3	Output Module Output #3 3J3-9
J17	VIDEO IN	Relay K1 Terminal 14 (To 1J1-1 when K1 deenergized)
J18	NOT USED	
J19	COLOR	Relay K1 Terminal 13 (To 1J1-1 when K1 energized)
J20	SYNC IN	Hor. AFC Module SEP. SYNC IN, 6J6-1
J21	(Loop thru)	
J22	3.58 IN	Color Module 3.58 MC IN, 5J5-24
J23	Terminated	
J24	H.D. OUT	Sync Logic Module Horizontal Drive Output, 9J9-10
J25	SYNC OUT	Output Module Sync Out, 3J3-24

On the front panel of each module are mounted the controls, switches and adjustments necessary to the function of the module in its relation to the other modules. Six of the modules have a series of test points on the front panel. The Power 1 Module has a meter for checking the voltage supply. The following chart is a convenient reference:

PANEL CONTROLS AND TEST POINTS

Panel Designation	*Symbol*	*Function*
Input and Blanking		
VID LEVEL	1R5	Adjusts the video gain
PEDESTAL	1R25	Adjusts the pedestal (black level)
VID IN	1TP1	Test point for checking video input signal
CL PUL	1TP2	Test point for checking clamping pulses
3.5V VID	1TP3	Test point for checking video signal after clamping
Output Module		
SYNC LEVEL	3R16	Adjusts amplitude of sync output
OUTPUTS		
1	3TP1	Test points for checking each output with sync added
2	3TP2	
3	3TP3	
VID IN	3TP5	Test point for checking the input video signal to the module
SYNC OUT	3TP6	Test point for checking sync output to the frame for use in the TRT System
Horizontal AFC		
31.5 KC	6R7	Adjusts master oscillator frequency
FREQ SET	6S1	Disables AFC for adjusting master oscillator frequency
÷2	6TP1	Test point to check 15.75 kc pulse counter
AFC SAW	6TP2	Test point to check sawtooth waveform
AFC PUL	6TP3	Test point to check AFC pulse at collector 6Q4
Vertical Advance		
STABILITY TEST	8R30 – 8S1	Check for marginal operation of multivibrators
÷7	8TP1	
÷5	8TP2	
÷5	8TP3	
÷3	8TP4	Test points to check the pulse width at each counter MV output.
3.5H	8TP5	Test point to check 3.5H
STRT PUL	8TP6	Test point to check Start Pulse
Sync Logic Module		
H. BLKG WIDTH	9R33	Adjusts horizontal blanking width
V. BLKG WIDTH	9R1	Adjusts vertical blanking width to 21H (1333.5 microseconds)
9H	9TP1	Test point to check 9H pulse
SYNC GATE	9TP2	Test point to check gated vertical sync
BL	9TP3	Test point to measure blanking output
Power 1 Module		
–22V ADJ	11R12	Adjusts to read –22V on meter 11M1
READ	11S1	Press switch to read –9V on meter 11M1
–9		
Power 2 Module		
–9V	12TP1	Test point to check –9V output
–22V	12TP2	Test point to check –22V output
Color Module		
RECORD PHASE	5R50 – 5S1	Adjusts burst phase in RECORD mode
CHR	5TP1	Test point to check amplitude of chroma signal after amplification
BLKG	5TP2	Test point to check blanking signal from Sync Logic Module
VID	5TP3	Test point to check video input to low pass filter
3.58 MC	5TP4	Test point to measure incoming 3.58 mc signal
BUR	5TP5	Test point to check new burst
SYNC	5TP6	Test point to check gated (9H) Horizontal Sync
PBLK PHASE	5R45	Adjusts burst phase in PLAYBACK mode
BURST	5R64	Adjusts burst amplitude
CHROMA	5R75	Adjusts chroma gain

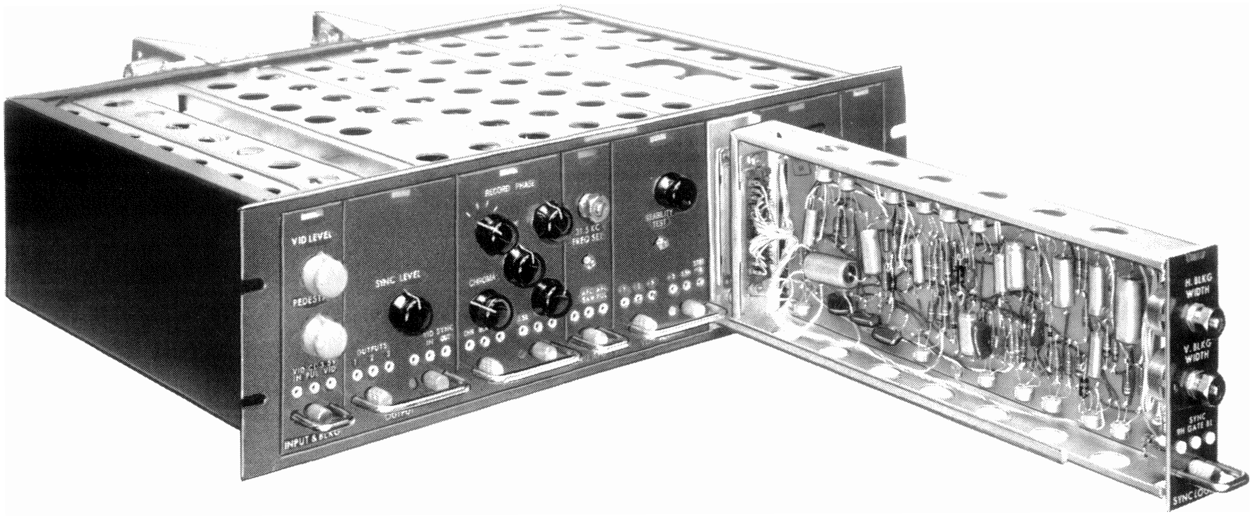


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Figure SPA-4. Signal Processing Amplifier with Extender

For convenience in servicing the individual modules under operating conditions, an accessory called an Extender has been supplied. As shown in figure SPA-4, this extender consists of a skeleton module with a duplicate receptacle mounted at each end so that the module to be serviced may be removed, the extender plugged in its place, and the module mounted on the extender. Both sides of the module may now be easily serviced. Although the mounting bracket is the width of the narrow modules, the wider modules may also be mounted on the bracket.

Orientation in TV Tape Recorder System

The processing amplifier modules receive the video signal (monochrome or color) and other related pulses through the coaxial jacks and the relay K1 (COLOR/MONO) which is mounted on the rear center of the amplifier frame. Output and input signals and pulses are also available for the modules and for the system through these jacks. The following tabulation shows the system unit-connections for the input and output signals of the processing amplifier:

Signal Processing Amplifier Frame		*TV Tape Recorder System Units*	
Inputs		*Unit-Connections*	
J17	VIDEO IN	Distribution Amplifier #2 (303)	OUTPUT B J6
J20	SYNC IN (Loop thru J21 to Ref. Generator J8)	2 X 1 Switcher (309)	SYNC OUT J8
J19	COLOR IN	Chroma Processor (604)	COLOR OUT J3
J22	3.58 MC IN (J23 terminated)	Subcarrier Converter (606)	REF 3.58 J2
Outputs		*Unit-Connections*	
J14	OUT #1	TV Tape Recorder System	TRT OUTPUT
J15	OUT #2	CRO Monitor Switcher (307)	LINE OUT J3
J16	OUT #3	Color Monitor Switcher (601)	LINE OUT J5
J24	SYNC OUT	TRT System	
J25	HOR DRIVE	TRT System	

Circuit Description

1. Overall

The block diagram, figure SPA-5, shows how the processing amplifier functions in a monochrome system and in a color system, when the Color Module has been included in the frame. However, the input and output modules function differently for each system. The other three pulse-forming modules perform specific and essential functions in contributing to the complete rejuvenation of the synchronizing elements of the video signal for both monochrome and color systems. The simplified schematics, figure SPA-7 for the monochrome system and figure SPA-8 for the color system, show the path of the video signal, ignoring for the moment the contributions from the pulse forming modules and power modules as shown in the block diagram.

As shown in figure SPA-7 for the monochrome system, the video signal from the tape recorder system is fed to the jack J17 and then to the relay K1, located on the rear of the mounting frame. Relay K1 is energized when the CHROME-MONOCHROME switch

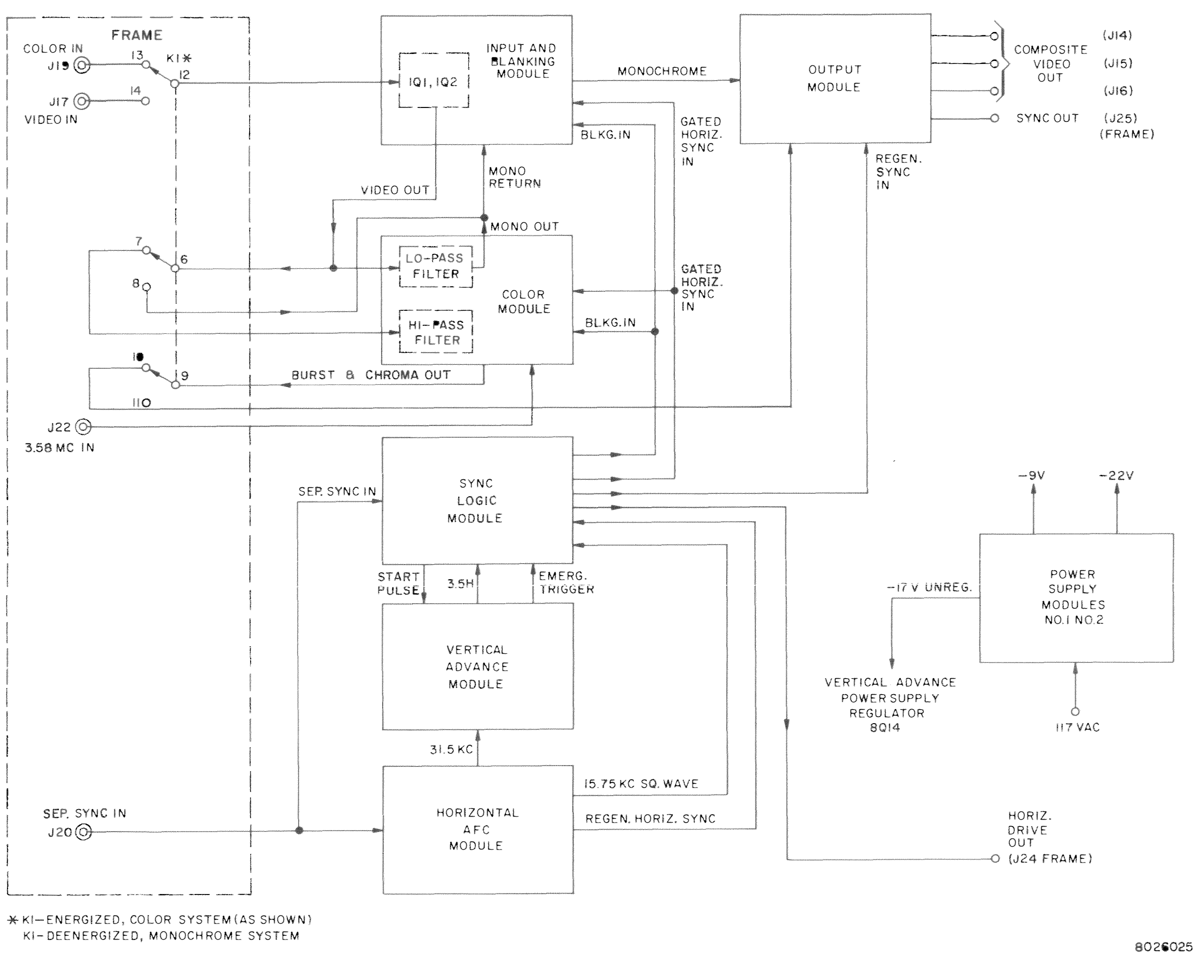


Figure SPA-5. Signal Processing Amplifier Block Diagram

S1 on the Demodulator, unit 201, is placed in the CHROME position and the TEST switch S1 on the Burst Oscillator, unit 605, is in the OPERATE position. Relay K1 is deenergized when the demodulator switch is placed in the VAR or MONO positions. With relay K1 deenergized, contacts 12 and 14 are closed, and the signal goes to 1J1-1 on the Input and Blanking Module. The signal is amplified by the amplifier 1Q1 and passed through the emitter follower 1Q2 to 1J1-16, VIDEO OUT. The signal then passes through the closed relay contacts 6 and 8 which effectively short the signal back to 1J1-18 (MONO RETURN) to the feedback amplifier 1Q3. The signal is amplified and clamped as explained on p. SPA-11. From the MONO OUT, 1J1-12, the signal passes to the Output Module through 3J3-1 and is amplified in 3Q1. This module recombines the video and regenerated sync to form a composite video signal, available at three output jacks, which is explained in detail on p. SPA-14.

As shown in figure SPA-8, for the color system, the color signal from the color equipment is fed to jack J19 and then to relay K1, located on the rear of the mounting frame. With the relay energized, contacts 12 and 13 are closed and the signal goes to 1J1-1 on the Input and Blanking Module. The signal is amplified by the amplifier 1Q1 and then passed through the emitter follower 1Q2 to 1J1-16, VIDEO OUT. The color signal then follows two paths. Through the first path, 5J5-1, in the Color Module, the low pass filter removes the chroma information and passes the luminance signal. This luminance signal is returned from 5J5-3 to 1J1-18 on the Input and Blanking Module for monochrome processing as outlined for the monochrome signal. The luminance signal is separated from the chroma information because the parts of the chroma signal below black level would be clipped off if the chroma were fed through the monochrome processing circuits. The other signal path is through the closed relay contacts 6 and 7 of K1 to 5J5-2 on the Color Module. Here the signal passes through a high pass filter which removes the luminance signal and passes the burst and chroma information. As explained in detail on p. SPA-40, here the old burst is clamped out and new burst is made from the local 3.58 mc reference subcarrier. Chroma and burst are then fed through relay K1-10 to the Output Module, 3J3-17 to the color adder 3Q2 which adds the chroma and burst to the output of the black-level clipper 3Q1. As explained for the monochrome signal system, the output module provides a video signal which is available at three separate outputs.

2. Input and Blanking Module

(Refer to Block Diagram Figure SPA-6.)

Monochrome

The video signal from the Tape Recorder System (Distribution Amplifier #2) is fed into the Signal Processing Amplifier through J17, which is mounted

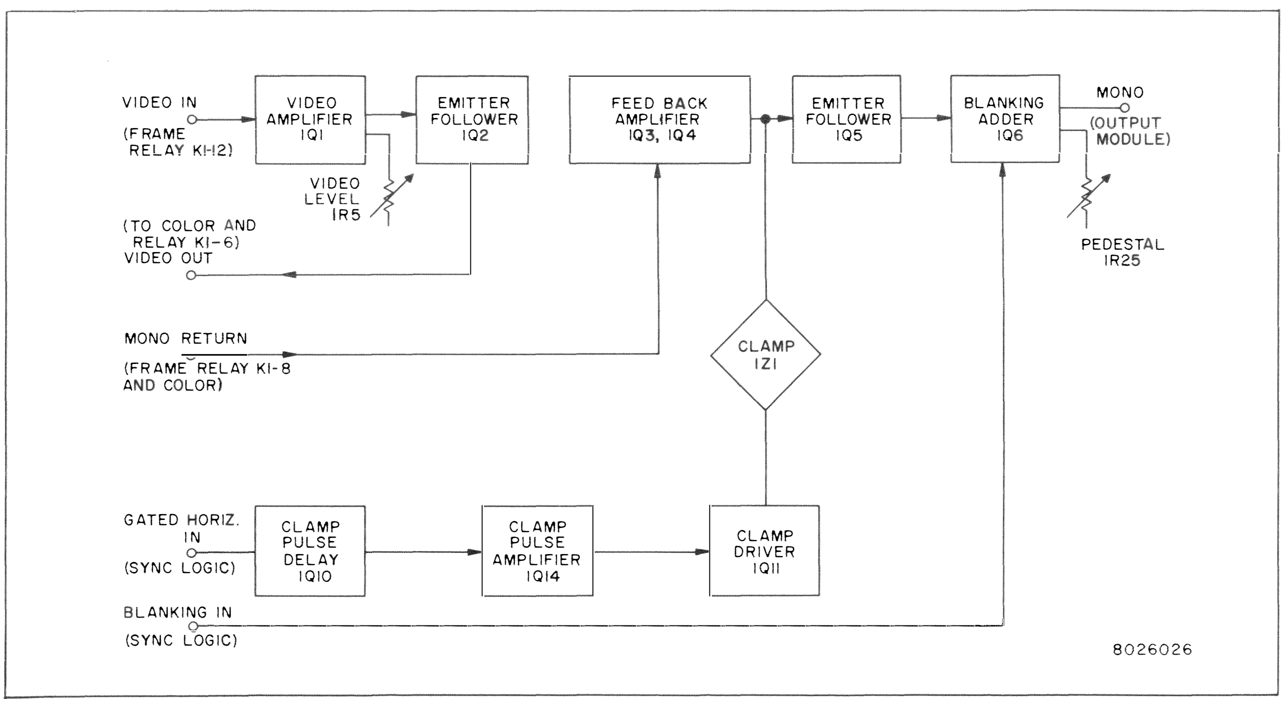


Figure SPA-6. Block Diagram of Input and Blanking Module

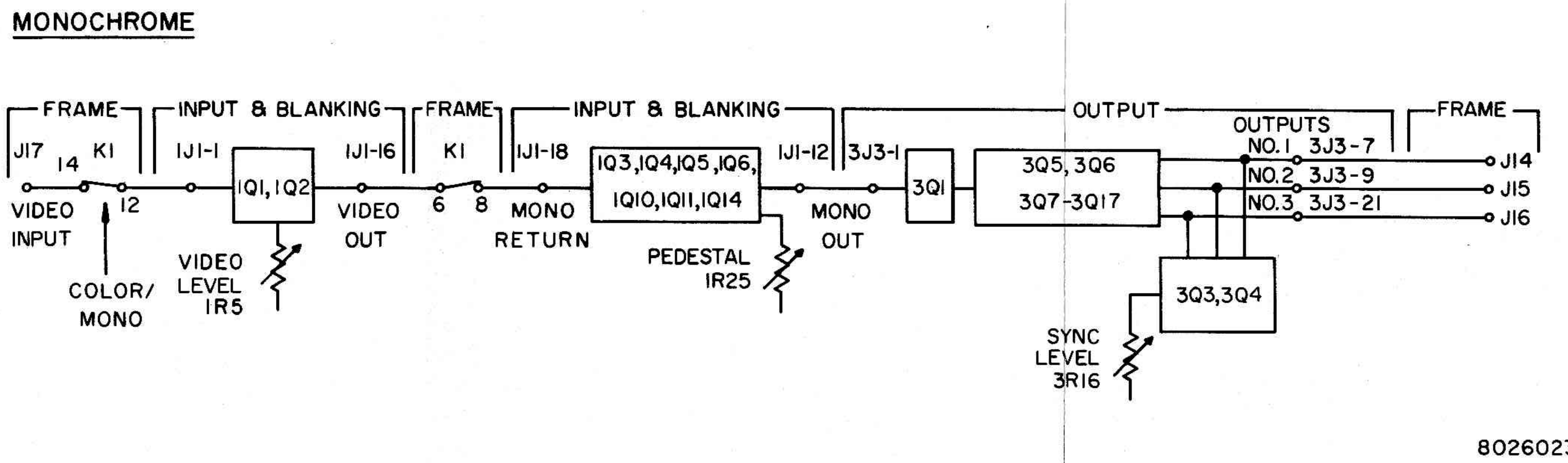


Figure SPA-7. Simplified Schematic for Monochrome System

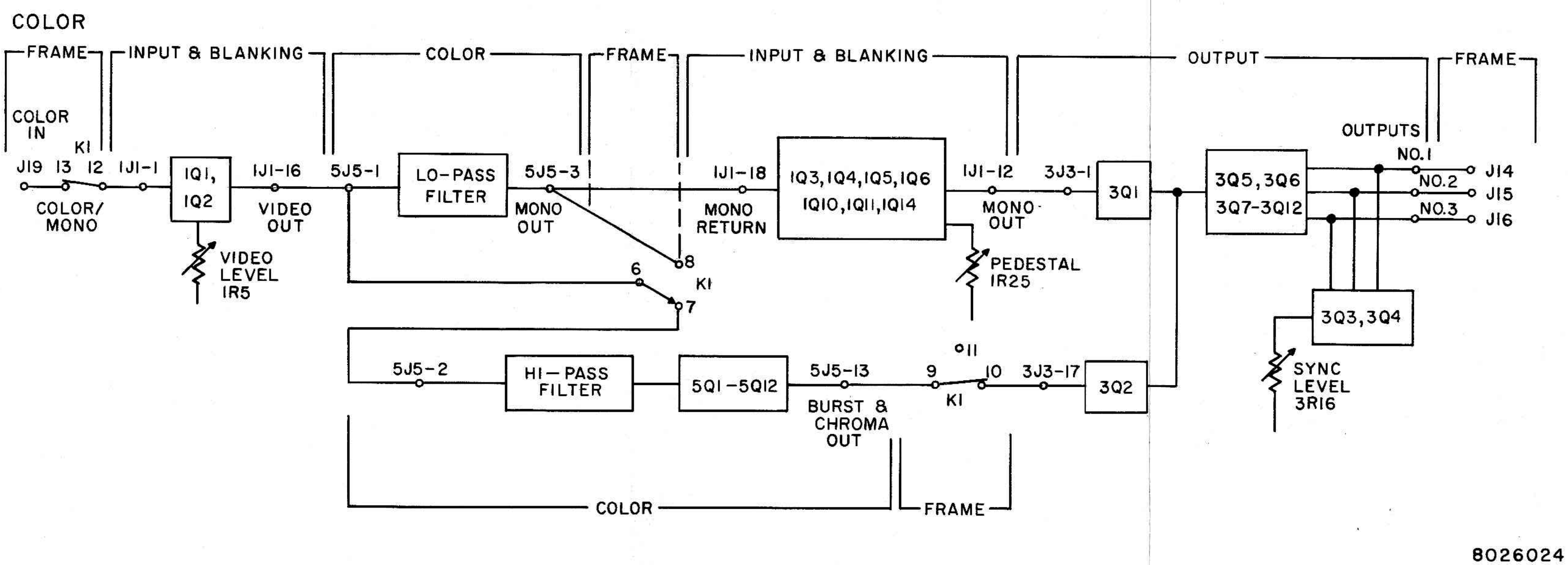


Figure SPA-8. Simplified Schematic for Color System

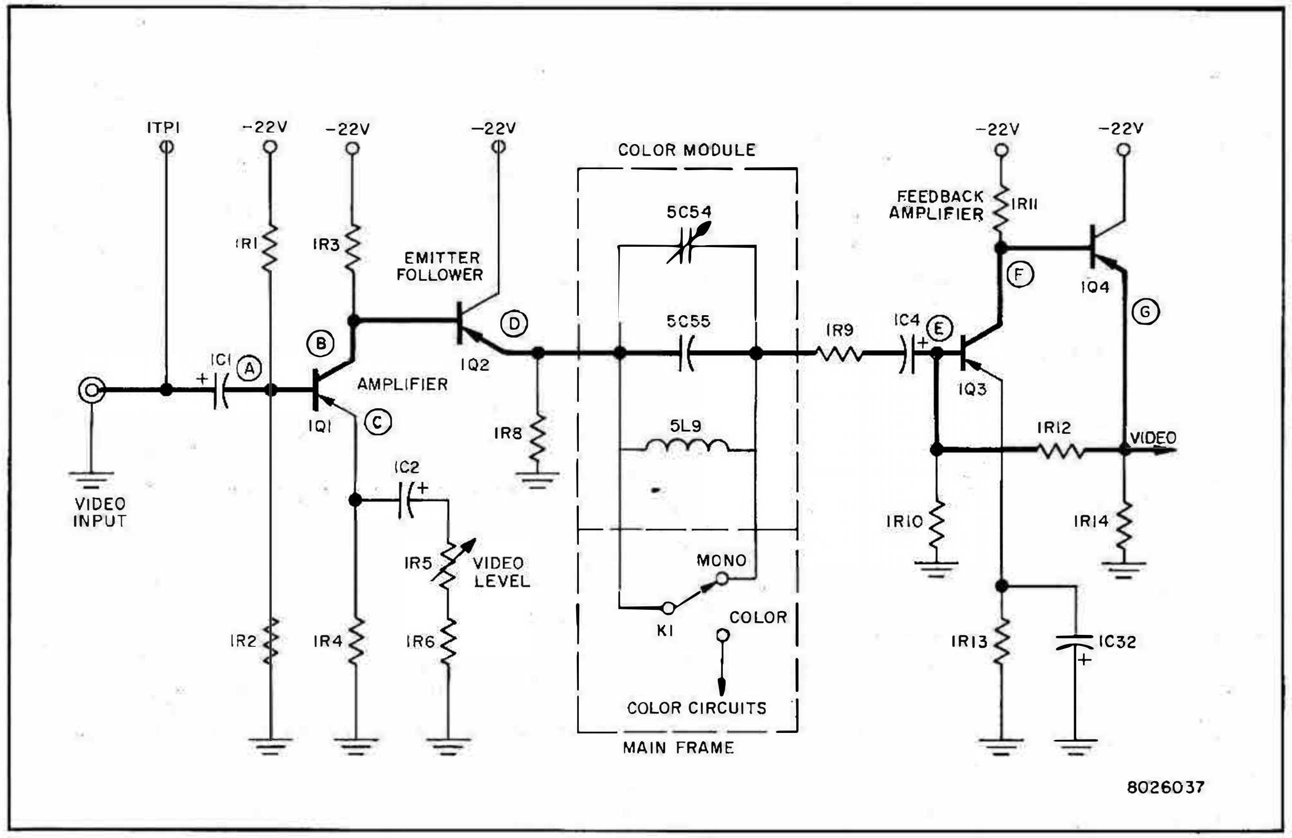
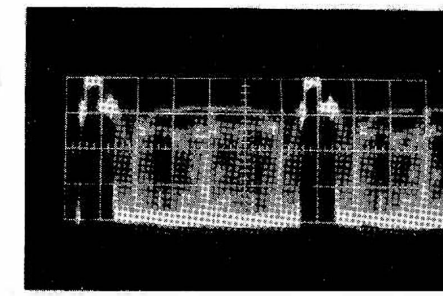


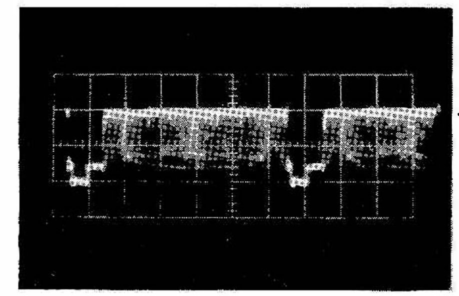
Figure SPA-9. Simplified Schematic of Input Section


-10

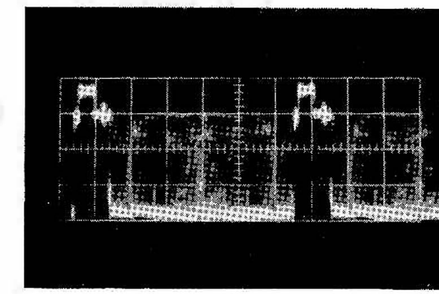
A. Base of 1Q1 at 10 micro-seconds/cm; 1v p-p.


-17

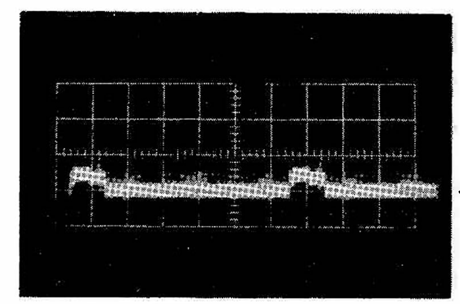
B. Collector of 1Q1 at 10 micro-seconds/cm; .2/division.


-10

C. Emitter of 1Q1 at 10 micro-seconds/cm; .5v/division.


-17

D. Emitter of 1Q2 at 10 micro-seconds/cm; .2v/division.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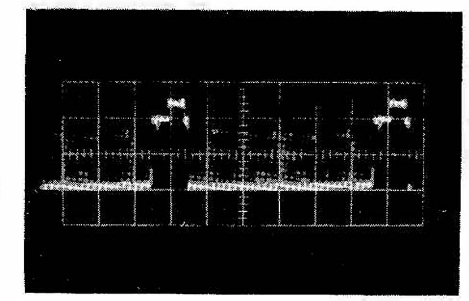
E. Base of 1Q3 at 10 micro-seconds/cm; .05v/division.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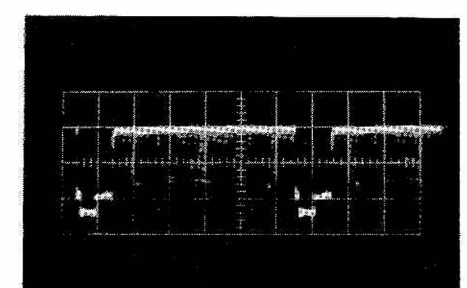
F. Collector of 1Q3 at 10 micro-seconds/cm; 2v/division.


-11

G. Emitter of 1Q4 at 10 micro-seconds/cm; 2v/division.

on the rear bracket of the frame. As shown in figure SPA-9, the signal passes through the deenergized relay K1 closed contacts 12 and 13 to 1J1-1 to the amplifier 1Q1. This circuit has a maximum gain of 2 and is adjusted by the VIDEO LEVEL control 1R5. Then the signal passes to 1Q2, an emitter follower, and out 1J1-16. With the relay contacts 6 and 8 closed, the signal is effectively shorted from 1J1-16 to 1J1-18, (MONO RETURN) to the feedback amplifier 1Q3 and 1Q4. The feedback amplifier provides the larger signal of 3.5 volts which is necessary for stable clamping and passes it to the emitter follower 1Q5 which is clamped at the proper operating point by the bridge-connected diodes in the clamp 1Z1. Refer to figure SPA-10. The clamp pulses are timed to occur during the back porch interval by the action of the clamp pulse amplifier 1Q10, a "boxcar" circuit* which is driven to cutoff by the negative going trailing edge of the gated horizontal sync pulse. This circuit remains cut off for a time determined by 1R39 and 1C16 which is approximately the back porch interval. The positive going pulses in the collector circuit are inverted in 1Q14 and applied by the clamp driver 1Q11, opposite in phase, across the clamp 1Z1. The clamp pulse cancels out in 1Z1 during the clamping interval. The signal passes from the emitter follower 1Q5 to the emitter of 1Q6 and out 1J1-12 to the Output Module. Blanking is supplied from the Sync Logic Module through 1J1-9 to the base of the blanking adder 1Q6 which operates in conjunction with the black clipper 3Q1. Refer to the following description of the Output Module. The PEDESTAL control 1R25, in the emitter circuit of 1Q6, adjusts the DC level of the combined signals relative to a fixed clipping level. The diode 1CR1 sets the DC level of the blanking signals at −12 volts obtained from the Output Module.

Color

The path of the color signal from J19 through 1Q1 and 1Q2 has been shown in figure SPA-8. The luminance signal returns through the MONO RETURN path to be processed as a monochrome signal which is then fed to 3Q1 in the Output Module.

* See Basic Circuit Descriptions on p. SPA-48.

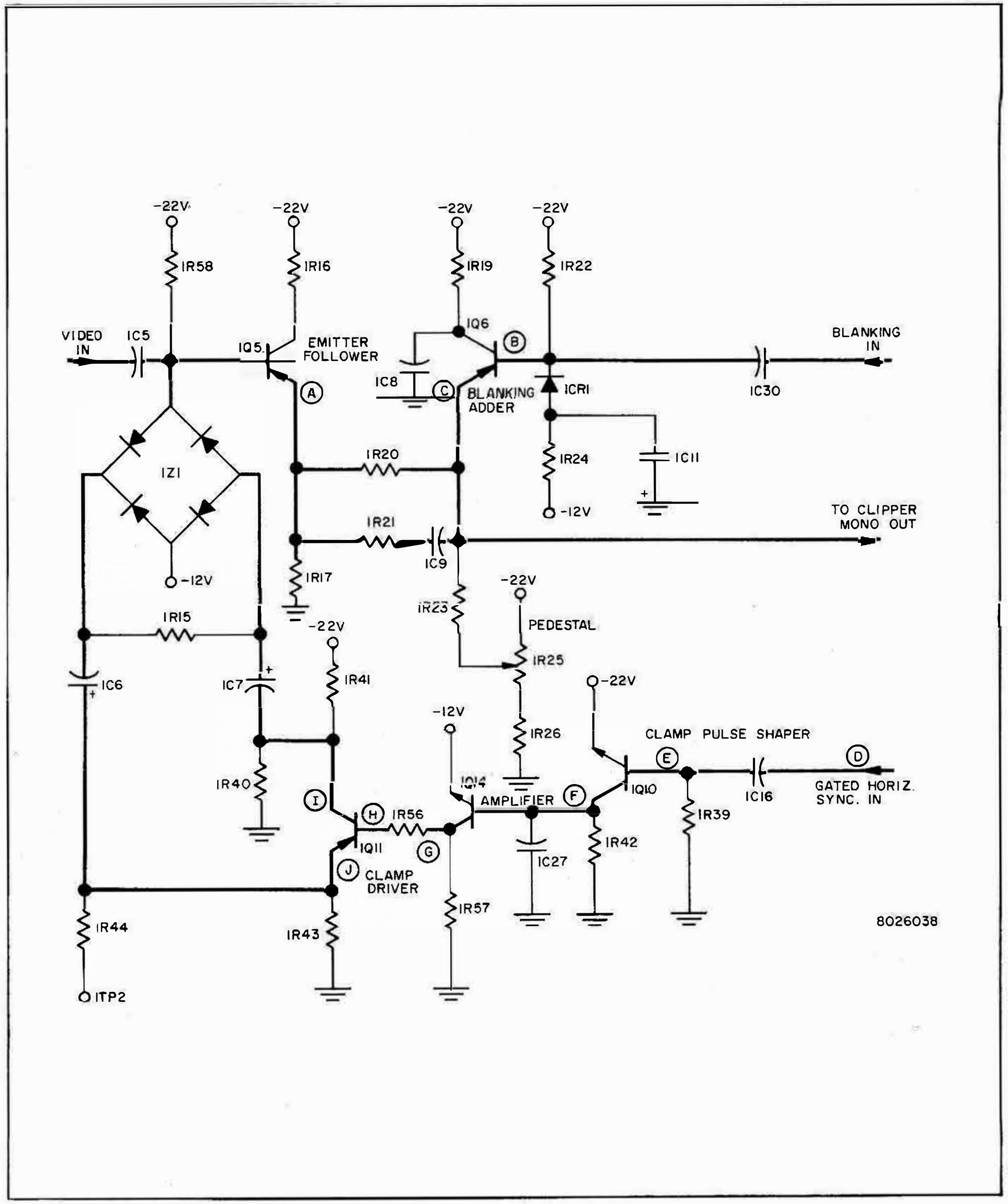
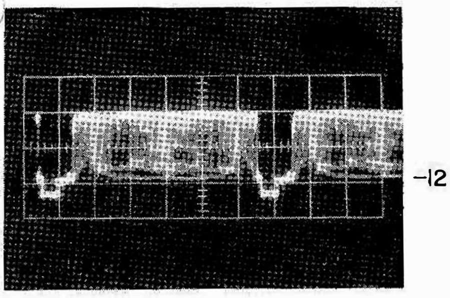
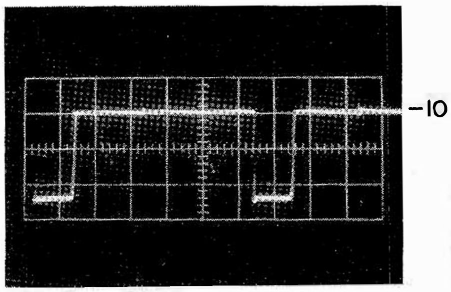


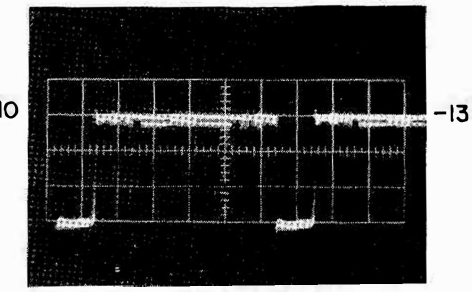
Figure SPA-10. Simplified Schematic of Clamp and Adder Section



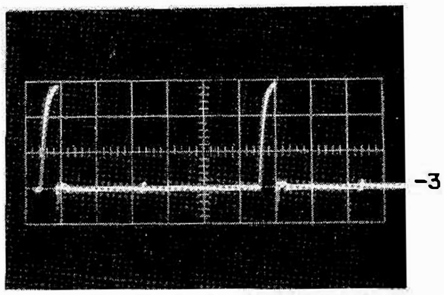
A. Emitter of 1Q5 at 10 micro-seconds/cm; 2v/division.



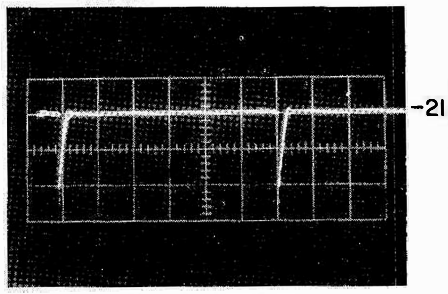
B. Base of 1Q6 at 10 micro-seconds/cm; 2v/division.



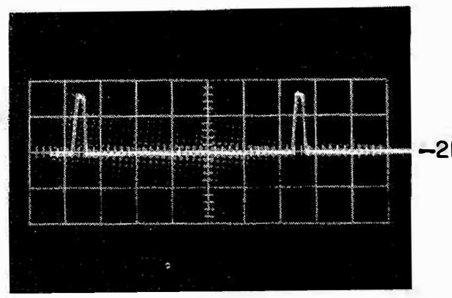
C. Emitter of 1Q6 at 10 micro-seconds/cm; .5v/division.



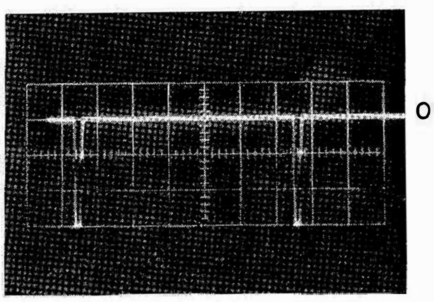
D. Gated Horiz. In 1J1-3 at 10 micro-seconds/cm; 1v/division.



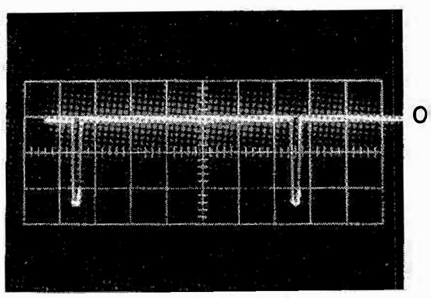
E. Base of 1Q10 at 10 micro-seconds/cm; 1v/division.



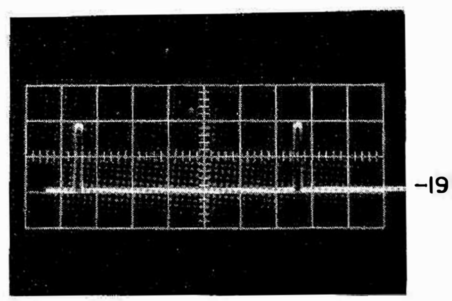
F. Collector of 1Q10 at 10 micro-seconds/cm; 5v/division.



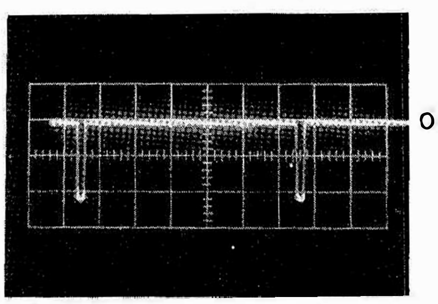
G. Collector of 1Q14 at 10 micro-seconds/cm; 5v/division.



H. Base of 1Q11 at 10 micro-seconds/cm; 5v/division.



I. Collector of 1Q11 at 10 micro-seconds/cm; 5v/division.



J. Emitter of 1Q11 at 10 micro-seconds/cm; 5v/division.

3. Output Module

(Refer to Block Diagram Figure SPA-11.)

Monochrome

The Output Module combines the video signal and regenerated sync to form the composite video signal, which is available at three output jacks on the frame. A separate regenerated sync output is also provided at jack J25.

As shown in the simplified schematic figure SPA-12, the processed monochrome signal from the Input and Blanking Module is fed to the black clipper 3Q1. This clipper circuit conducts when the emitter voltage is more positive than the —12 volts supplied to the base. This —12 volts is also supplied to the blanking adder 1Q6 which in conjunction with 3Q1 effectively clips all signals blacker-than-black at the blanking level. The series amplifiers 3Q5 and 3Q6 serve as the driver stage for each of the three identical series output stages.

Regenerated sync from the Sync Logic Module is fed to the base of the sync output 3Q3 and to the sync adder 3Q4 through the pulse-shaping circuits, 3R7, 3C7 and 3R8, 3C8 respectively. Refer to figure SPA-13. The potentiometer 3R16, SYNC LEVEL, is in series with the resistor 3R21. The sync output of 3Q4 is added to each of the three video outputs through the isolation resistors 3R18, 3R22, 3R23. The switch 3S1, located on the side of the module, is normally in the ON position but may be turned to OFF to remove sync from the video signal at OUTPUT #1, if desired. The sync output is obtained from the collector circuit of 3Q3 through resistor 3R2 which provides a sound termination for the line.

Color

In the color system, the luminance signal is processed in the Input and Blanking Module through the same circuitry as the monochrome signal, from the input to the black clipper 3Q1. From the Color Module, chroma and burst are fed to the color adder 3Q2. The output of 3Q2 is added to the output of 3Q1 in the common load resistors, 3R9 in parallel with 3R12. This video signal then passes through the driver stage and the three identical series amplifiers to which sync is added to provide three color outputs.

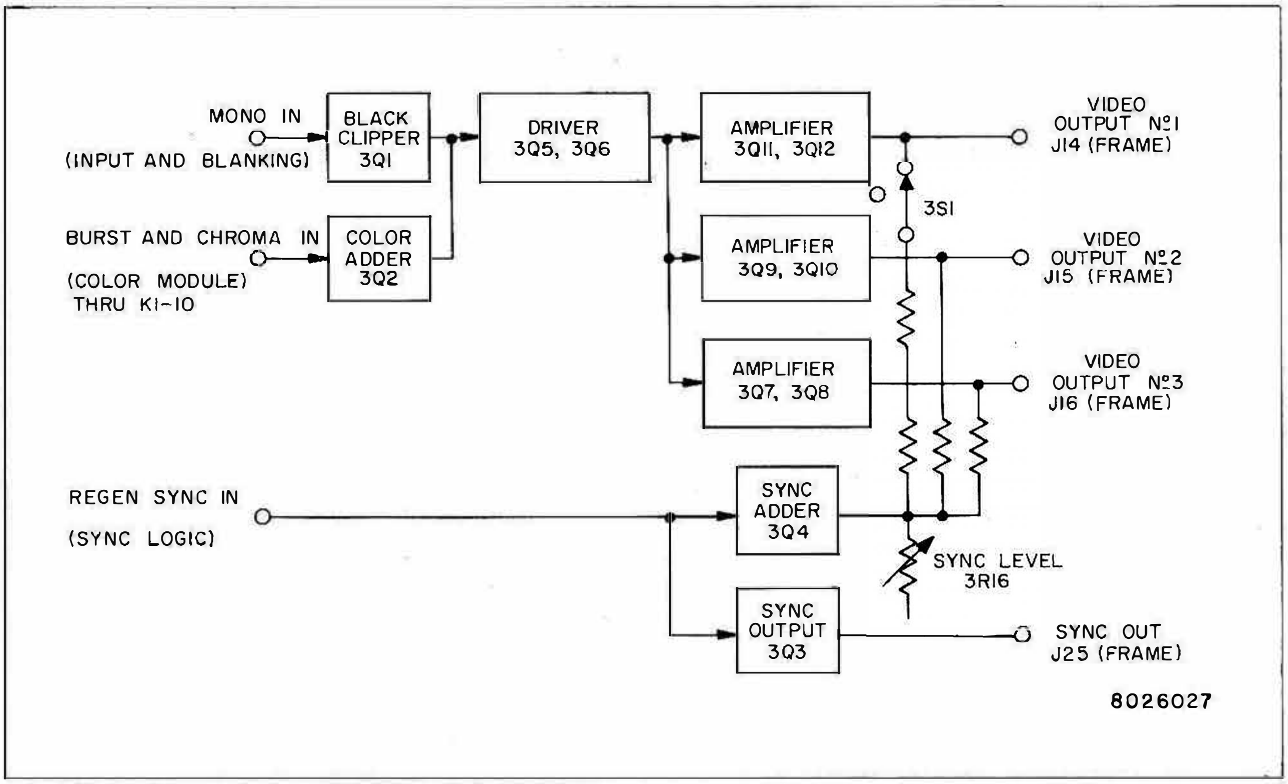
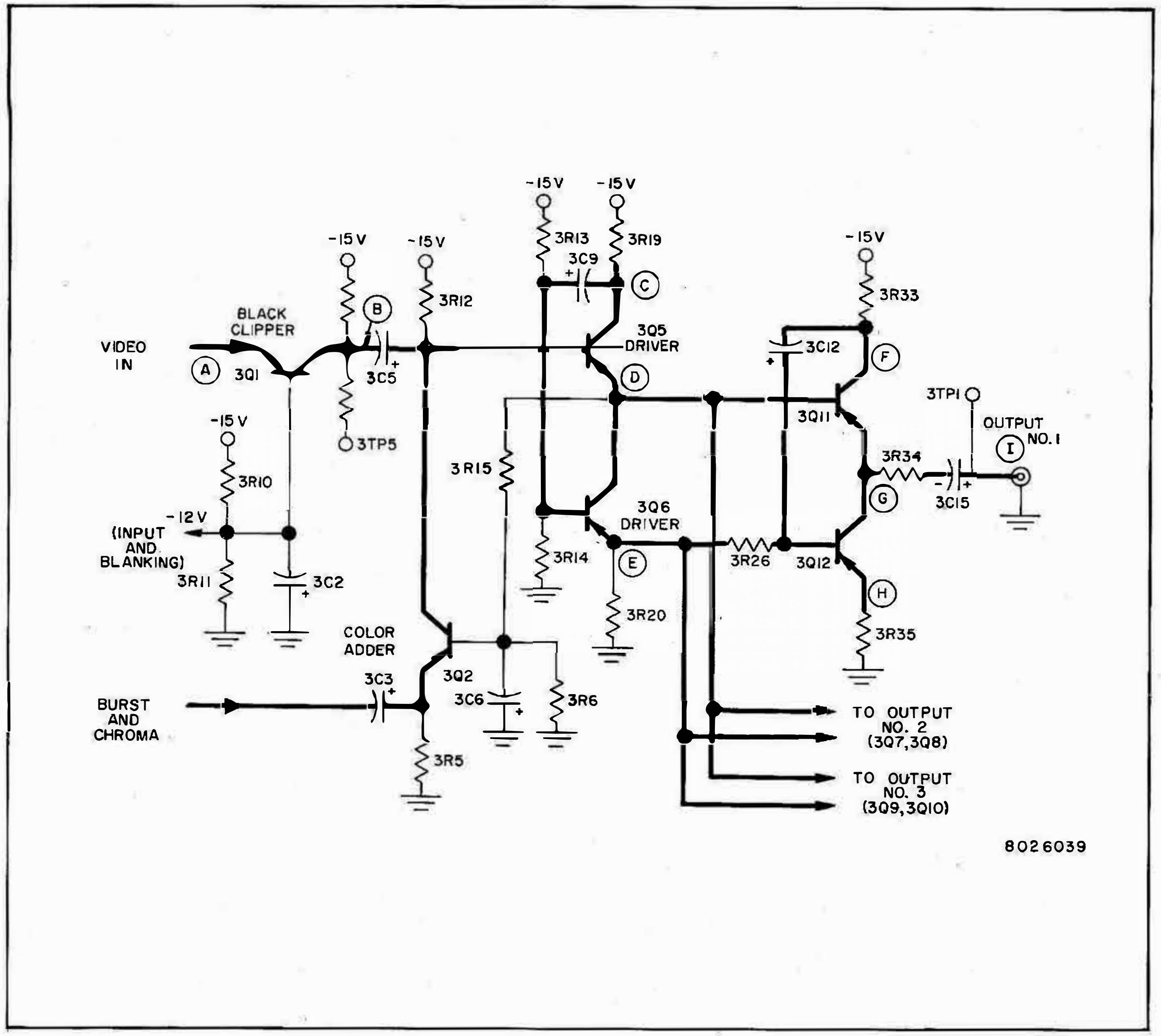
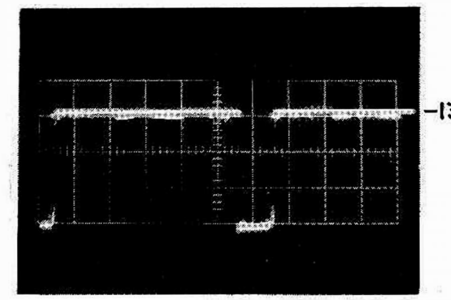
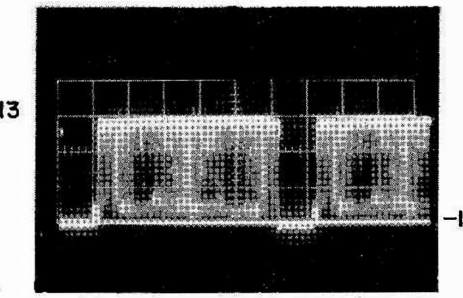


Figure SPA-11. Block Diagram of Output Module

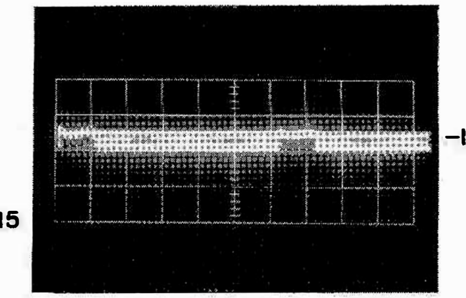




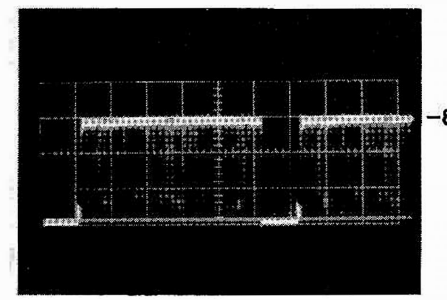
A. Emitter 3Q1 at 10 microseconds/cm; .5v/division.



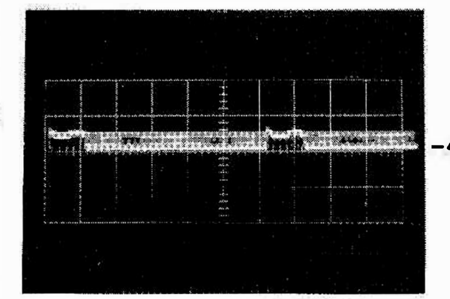
B. Collector of 3Q1 at 10 microseconds/cm; .5v/division.



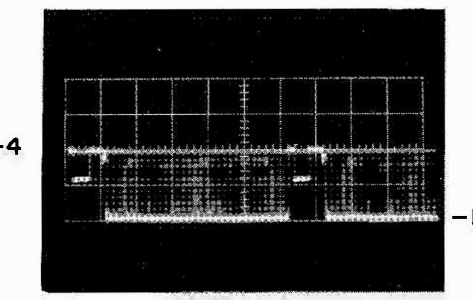
C. Collector of 3Q5 at 10 microseconds/cm; .5v/division.



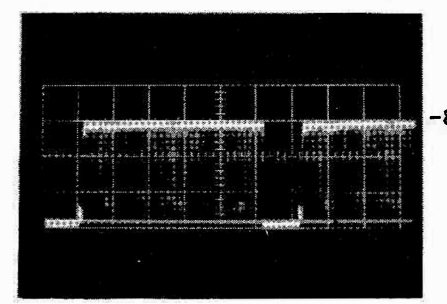
D. Emitter of 3Q5 at 10 microseconds/cm; .5v/division.



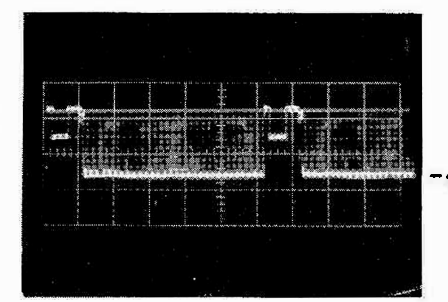
E. Emitter of 3Q6 at 10 microseconds/cm; .5v/division.



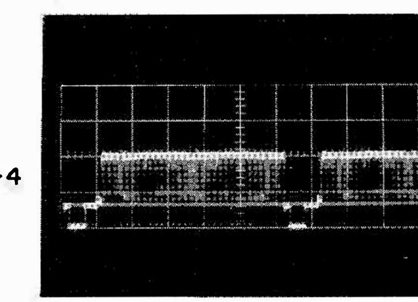
F. Collector of 3Q7, 3Q9, 3Q11 at 10 microseconds/cm; .5v/division.



G. Collector of 3Q8, 3Q10, 3Q12 at 10 microseconds/cm; .5v/division.



H. Emitter of 3Q8, 3Q10, 3Q12 at 10 microseconds/cm; .5v/division.

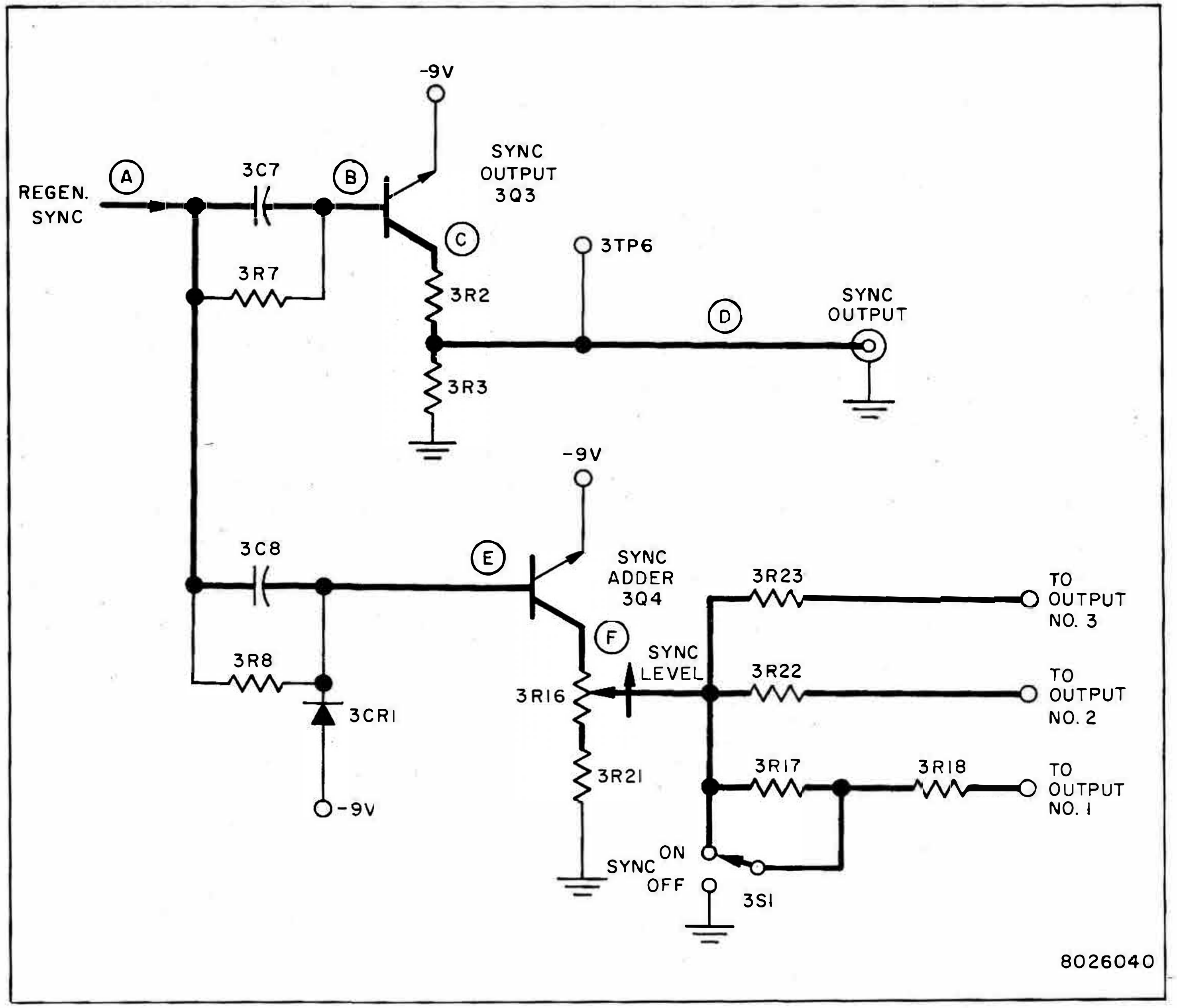


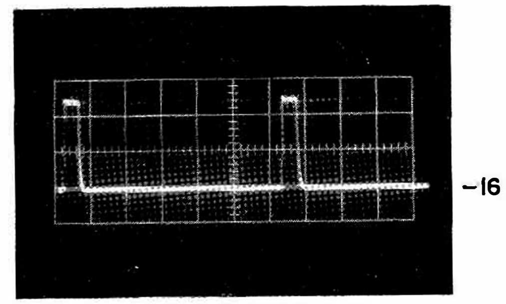
I. Test Point 3TP1, with switch 3S1 in ON Position, at 10 microseconds/cm; .5v/division.

NOTE: Monochrome operation only; no burst and chroma added.

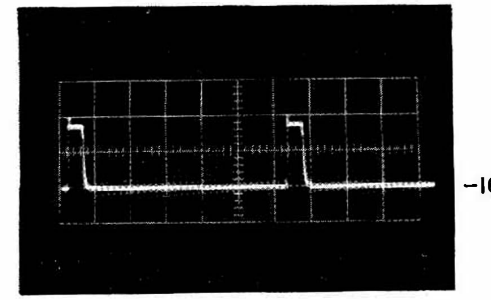
Figure SPA-12. Simplified Schematic of Clipper and Output Amplifier Sections

OUTPUT MODULE

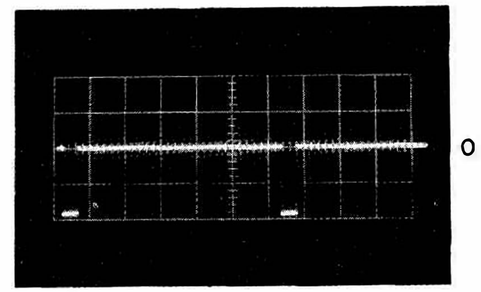




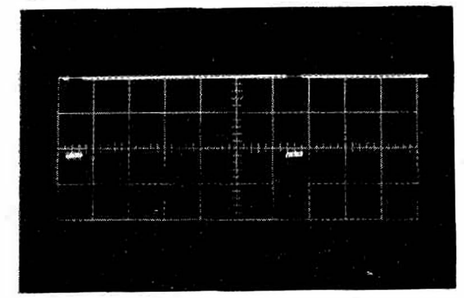
A. Regen. Sync In 3J3-3 at 10 micro-seconds/cm; 5v/division.



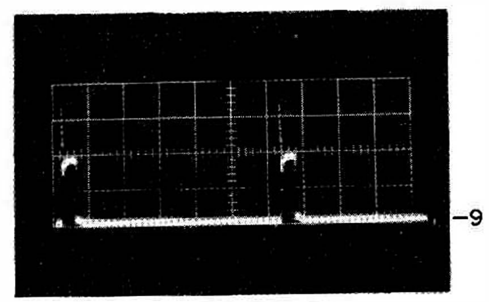
B. Base of 3Q3 at 10 micro-seconds/cm; 5v/division.



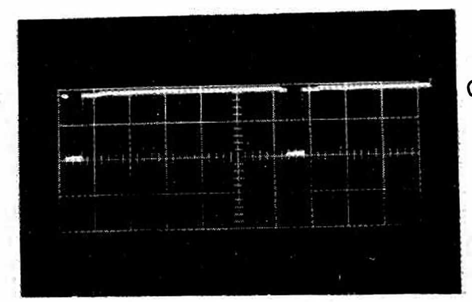
C. Collector of 3Q3 at 10 micro-seconds/cm; 5v/division.



D. Sync Out 3J3-20 at 10 micro-seconds/cm; 2v/division.



E. Base of 3Q4 at 10 micro-seconds/cm; .5v/division.



F. Collector of 3Q4 at 10 micro-seconds/cm; 5v/division.

Figure SPA-13. Simplified Schematic of Sync Adder Section

4. Pulse Forming Modules

The three pulse-forming modules, Horizontal AFC, Vertical Advance, and Sync Logic, form a sync timing and regeneration system. These three modules are closely interlinked functionally and physically to produce blanking, gated horizontal sync, regenerated sync and horizontal drive. The blanking pulses needed for both monochrome and color tape recording systems must be regenerated from the sync pulse.

Several advanced concepts in pulse circuitry have been used in designing these modules. The description of these techniques and circuits is discussed where applicable; however, when the information is applicable to more than one circuit, refer to Basic Circuit Descriptions, p. SPA-47, which cover the details of new pulse-forming transistor circuits. A block diagram and waveforms, keyed to simplified schematics for the functions accomplished in each module, clarify the crisscrossing between modules.

a. HORIZONTAL AFC MODULE.
(Refer to Block Diagram Figure SPA-14.)

Of the three-pulse forming modules the Horizontal AFC is the most straight-forward because it produces a 31.5 kc pulse, a 15.75 kc horizontal square wave and a horizontal sync pulse. The 31.5 kc pulse is provided for the Vertical Advance Module and the 15.75 kc horizontal square wave, for the Sync Logic Module. In contrast to the Horizontal AFC Module, the Vertical Advance Module and the Sync Logic Module are closely tied together in that they trigger each other to achieve a continuous flow of correctly timed pulses.

Horizontal Pulse Advance Technique

The sync signal is easily recovered from the incoming composite video; however, the blanking signal which cannot be removed reliably, must be regenerated from sync. The desired blanking pulse must precede by 1.7 microsecond (nominal front porch width) the sync signal from which it is generated. Since sync and blanking are both recurrent pulses, the position of the next sync pulse from the position of the preceding one may be predicted. Although a simple delay multivibrator with a nominal pulse width of 62.2 microseconds might seem useful for this purpose, its accuracy in pulse width and frequency is inherently inadequate for the application. Even if the tolerance of better than ±0.1% required in the multivibrator to hold the front porch width to within 3%

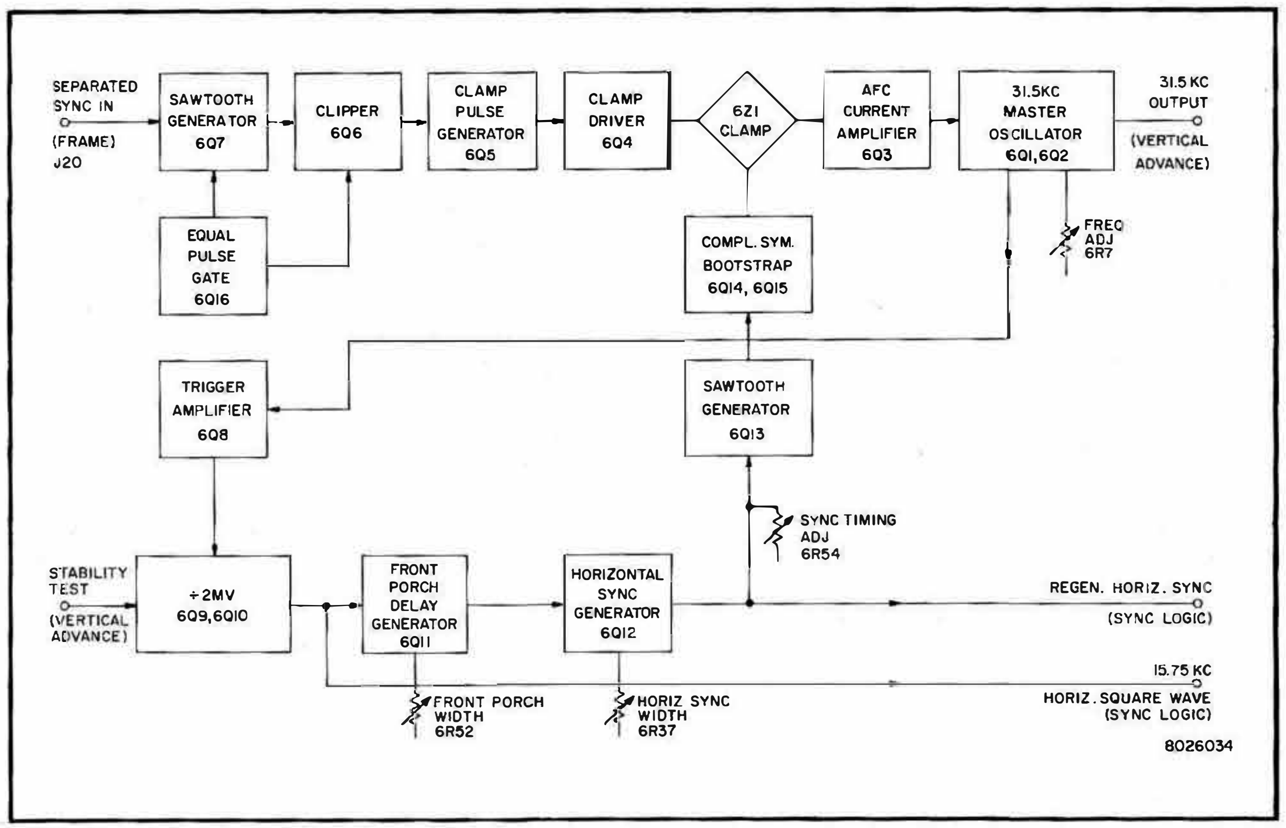


Figure SPA-14. Block Diagram of Horizontal AFC Module

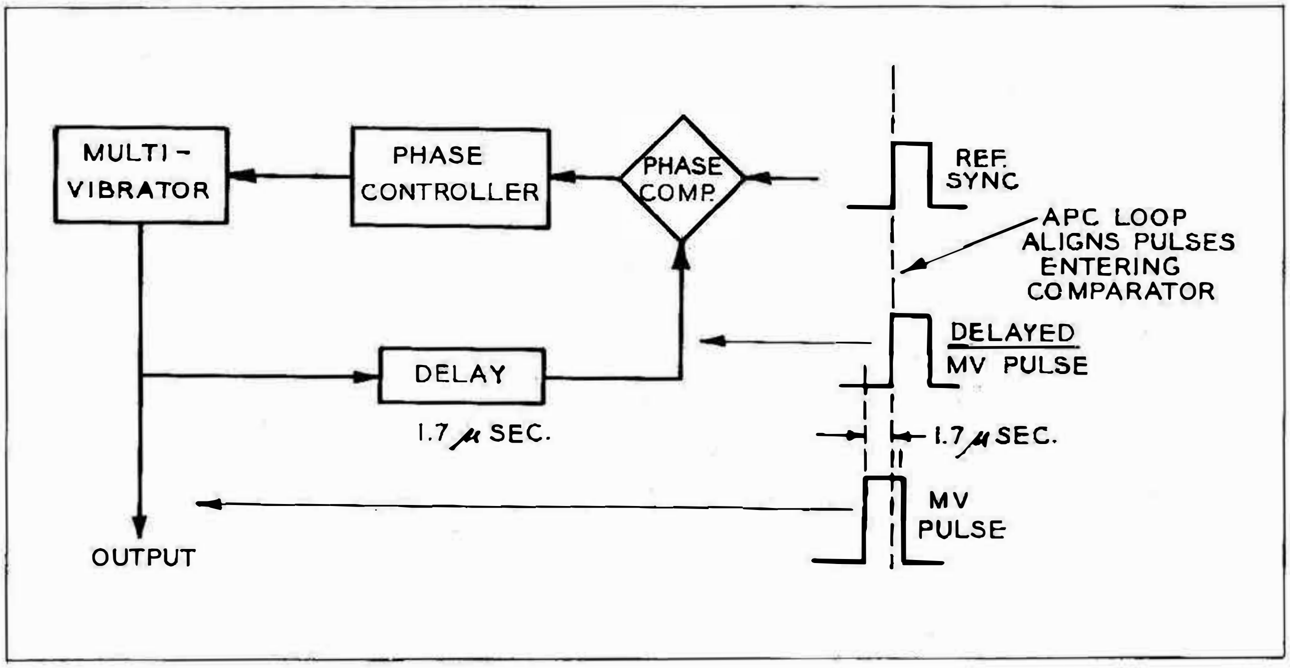


Figure SPA-15. Block Diagram Showing Pulse Advance Circuit

were met, changes in horizontal frequency of only $+1\%$ would reduce the front porch from its nominal 1.7 microseconds to 0.43 microseconds, which is less than half the allowable minimum.

Horizontal pulse advance is obtained through the multivibrator master oscillator, 6Q1, 6Q2, for which the frequency and phase is controlled by an automatic phase control circuit referenced to the incoming separated sync. The block diagram, figure SPA-15, clarifies this technique. The feedback loop which controls the phase of the multivibrator contains a 1.7 microsecond delay. The APC loop aligns the two pulses appearing at the phase comparator. However, the multivibrator pulse is delayed by 1.7 microseconds before reaching the comparator. Thus, the undelayed multivibrator pulse *precedes* sync by 1.7 microseconds and is properly timed to regenerate horizontal blanking. In this system, the feedback loop tracks any changes in horizontal frequency, eliminating variation in front porch width due to frequency changes; also, a one percent change in delay causes only one percent change in porch width.

Circuitry

The master oscillator is an astable multivibrator* used to produce a square wave. The free running frequency of the master oscillator, as shown in figure SPA-16, is determined by the charging time of capacitors 6C2 and 6C3 through the resistors 6R7, 6R8, and 6R9. An AFC current from the AFC amplifier 6Q3, added to the charging current, corrects the frequency and phase of the master oscillator. The frequency is set to approximately 31.5 kc by the FREQ. ADJ. control 6R7, using a fixed value of AFC current. This fixed AFC current is obtained by pressing the SET-RUN switch 6S1 to the SET position according to the procedure in *Maintenance, Adjustment of Master Oscillator Frequency.* From the collector of 6Q1, the output of the 31.5 kc square wave goes to the Vertical Advance Module and also to the trigger amplifier 6Q8 where it is coupled to the base by capacitor 6C14.

To provide a 15.75 kc square wave (half the 31.5 kc pulse) which is properly timed for the generation of horizontal blanking and horizontal drive in the Sync Logic Module, the divide-by-two monostable multivibrator, 6Q9, 6Q10, is triggered from the trigger amplifier 6Q8. Refer to figure SPA-17. Both transistors of the $\div 2$ multivibrator* are saturated in the stable state and driven to cutoff by a positive trigger pulse. The time constant 6C16 and 6R30 determines the duration of the cutoff period which is slightly greater than the period of the 31.5 kc trigger. Both

* See Basic Circuit Descriptions on p. SPA-47.

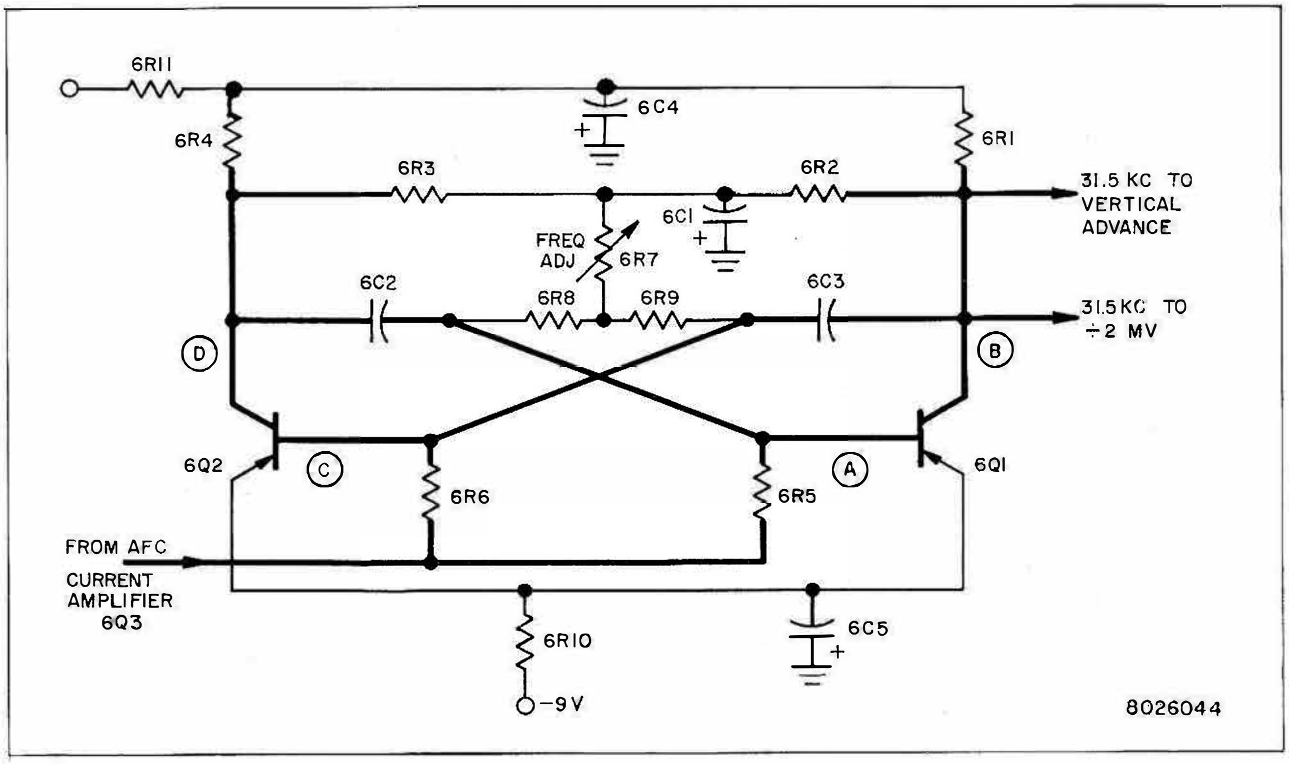
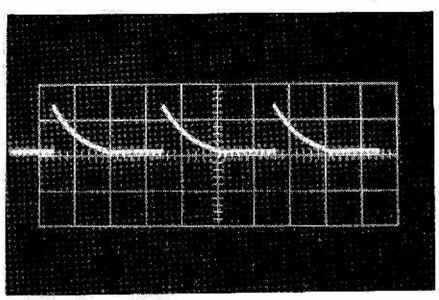
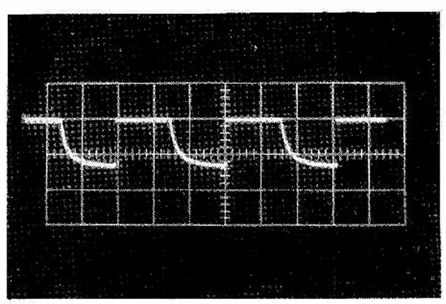


Figure SPA-16. Simplified Schematic of Master Oscillator Section



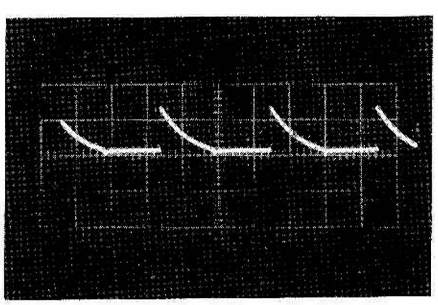
−10

A. Base of 6Q1 at 10 micro-seconds/cm; 5v/division.



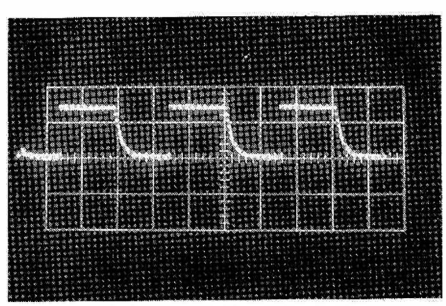
−9

B. Collector of 6Q1 at 10 micro-seconds/cm; 5v/division.



−10

C. Base of 6Q2 at 10 micro-seconds/cm; 5v/division.



−16

D. Collector of 6Q2 at 10 micro-seconds/cm; 5v/division.

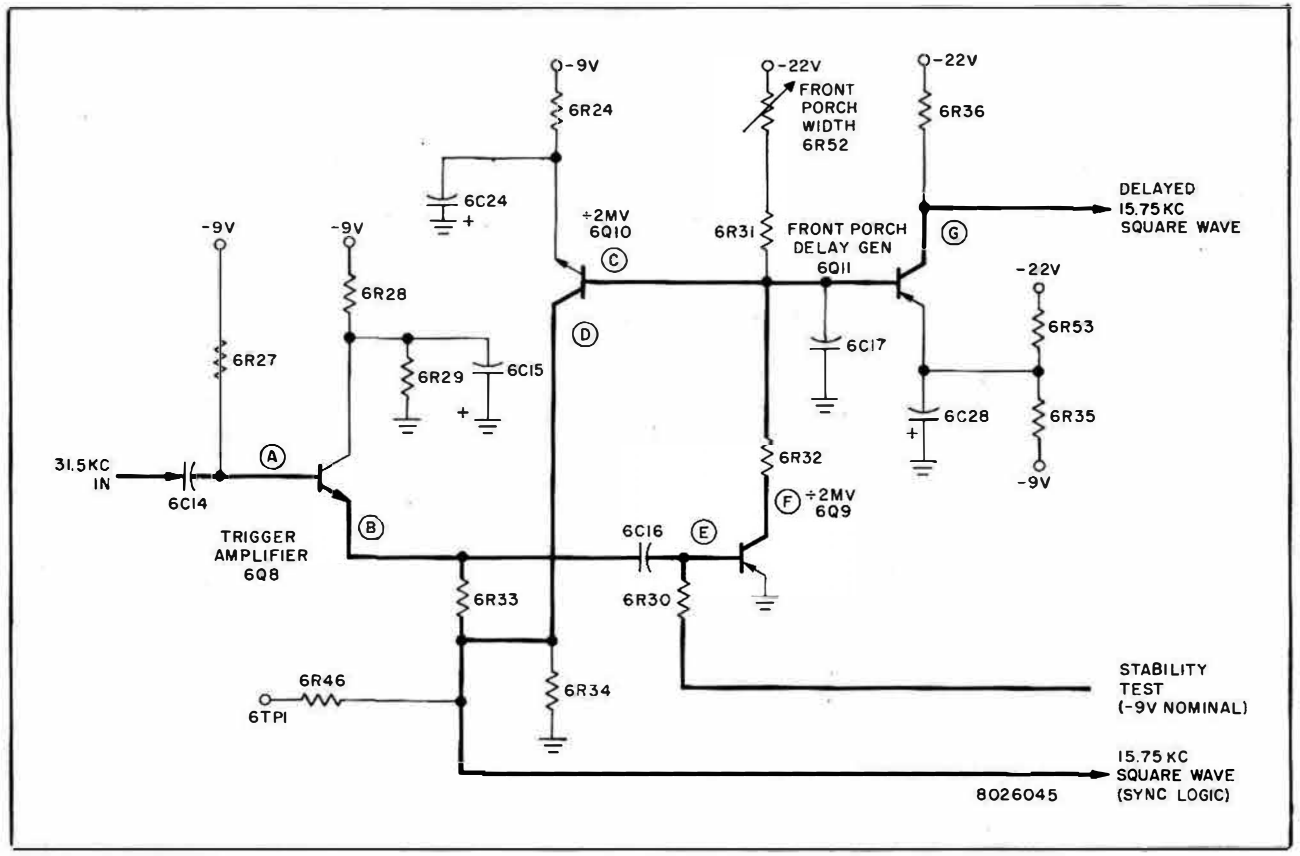


Figure SPA-17. Simplified Schematic of ÷2 MV Counter Section

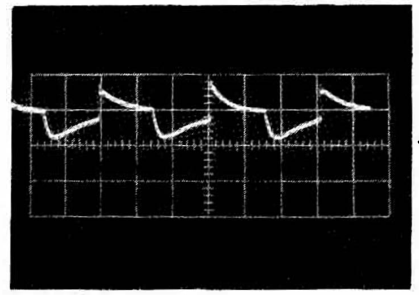
transistors then revert to the saturated state until the next trigger pulse.

A gating action is accomplished by DC connecting the emitter of 6Q8 to the collector of 6Q10. Refer to figure SPA-18. When 6Q10 is in the saturated or stable state, the 6Q10 collector and 6Q8 emitter are at −9v. Since the voltage at the collector of 6Q8 is approximately −4.5 volts, through the voltage divider 6R28 and 6R29, the transistor is capable of passing a trigger pulse applied to its base. Coupled to the base of 6Q9, the positive going trigger pulse at the emitter of 6Q8 cuts off 6Q9 which simultaneously cuts off 6Q10. When 6Q10 is cut off, the voltage at its collector and at the emitter of 6Q8 rises to 0 volts making it impossible for 6Q8 to pass trigger pulses. Amplifier 6Q8 is biased so that it does not pass the negative going pulses applied to its base.

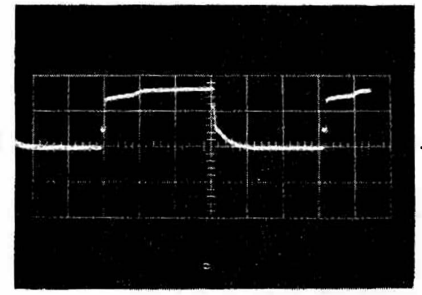
A 15.75 kc square wave from the collector of 6Q9 is fed to the base of the front porch delay generator 6Q11. The shunt capacitor 6C17 at the base of 6Q11 slows down the rise time of the square wave. Transistor 6Q11 does not conduct until the potential in the base falls to approximately the fixed emitter potential formed by the voltage divider, 6R35 and 6R53. The time taken to reach this potential is the delay time. In conduction, the 6Q11 circuit produces, at the collector, a fast-rise-time square wave whose leading edge is delayed from that of the input square wave. By setting the rise-time of the input square wave, potentiometer 6R52, the FRONT PORCH DELAY control, sets the delay in conduction of 6Q11.

As shown in figure SPA-18, this delayed 15.75 kc square wave output is coupled to the base of 6Q12. The horizontal sync generator 6Q12 is a pulse narrowing* circuit (boxcar). The width of the pulse is determined by the time constant 6C18 and 6R38 and 6R37, the potentiometer HOR SYNC WIDTH. Regenerated horizontal sync for the Sync Logic Module is taken from the collector of 6Q12.

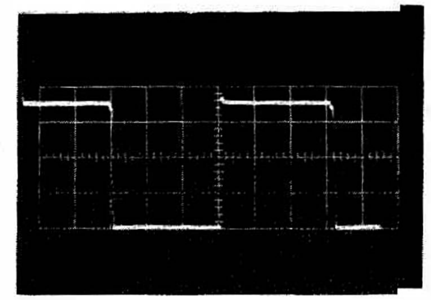
* See Basic Circuit Descriptions on p. SPA-48.


-12

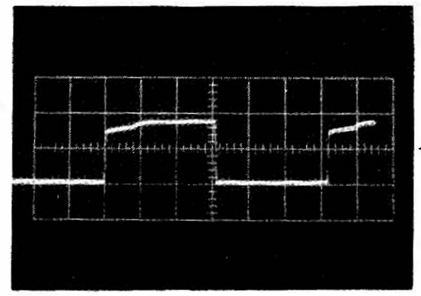
A. Base of 6Q8 at 10 microseconds/cm; 5v/division.


-8

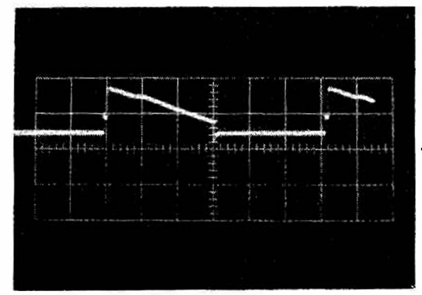
B. Emitter of 6Q8 at 10 microseconds/cm; 5v/division.


-5

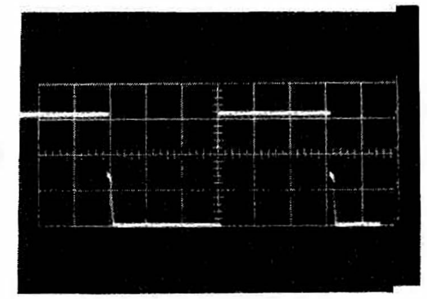
C. Base of 6Q10 at 10 microseconds/cm; 2v/division.


-2

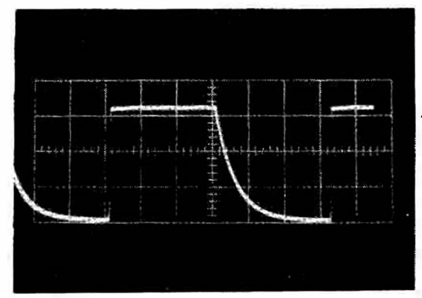
D. Collector of 6Q10 at 10 microseconds/cm; 5v/division.


-2

E. Base of 6Q9 at 10 microseconds/cm; 5v/division.


0

F. Collector of 6Q9 at 10 microseconds/cm; 5v/division.


-14

G. Collector of 6Q11 at 10 microseconds/cm; 2v/division.

HORIZONTAL AFC MODULE

The horizontal sync pulse is also coupled to the base of the sawtooth generator 6Q13. The integrating network 6R40, 6R54 and 6C19, slows down the rise time of the sync pulse enough to permit a slight delay in the time of conduction for 6Q13. This delay contributes to the total advance in timing of the 31.5 kc square wave relative to separated sync; however, it does not affect the front porch width since that width is determined only by the delay between the 15.75 kc square wave (used to generate horizontal blanking) and the leading edge of regenerated horizontal sync. The SYNC TIMING control 6R54 allows adjustment of the total delay over a small range so that the leading edge of regenerated horizontal sync may be made coincident with the leading edge of incoming separated sync. Therefore, when regenerated horizontal sync is combined with the vertical interval of separated sync in the Sync Logic Module the equalizing pulses and the vertical sync pulses are correctly timed with respect to the horizontal sync pulses.

The sawtooth generator 6Q13 conducts when the integrated sync pulse on its base drops to approximately the voltage on the emitter which is fixed by the voltage divider network 6R41 and 6R42. When 6Q13 conducts, it provides a low impedance discharge path for capacitor 6C23. Then when transistor 6Q13 is cut off by the decay of the input sync pulse, 6C23 charges slowly through 6R43 and 6R44, generating a sawtooth voltage. The sawtooth voltage at the collector is direct-coupled to the bases of the complementary symmetry bootstrap transistors, 6Q14 and 6Q15. This bootstrap circuit increases the linearity of the sawtooth waveform; the complementary symmetry arrangement provides sufficient current gain to drive the phase comparator. The output is taken from the emitters of 6Q14 and 6Q15.

During the vertical interval, equalizing pulses and vertical sync serrations occur at twice the rate (31.5 kc) of the horizontal sync pulses. If this "double frequency" (half-line) information is permitted to trigger the clamp pulse generator, the phase comparator would be keyed on during the wrong part of the sawtooth voltage cycle and thus provide wrong AFC information to the master oscillator. The circuitry as

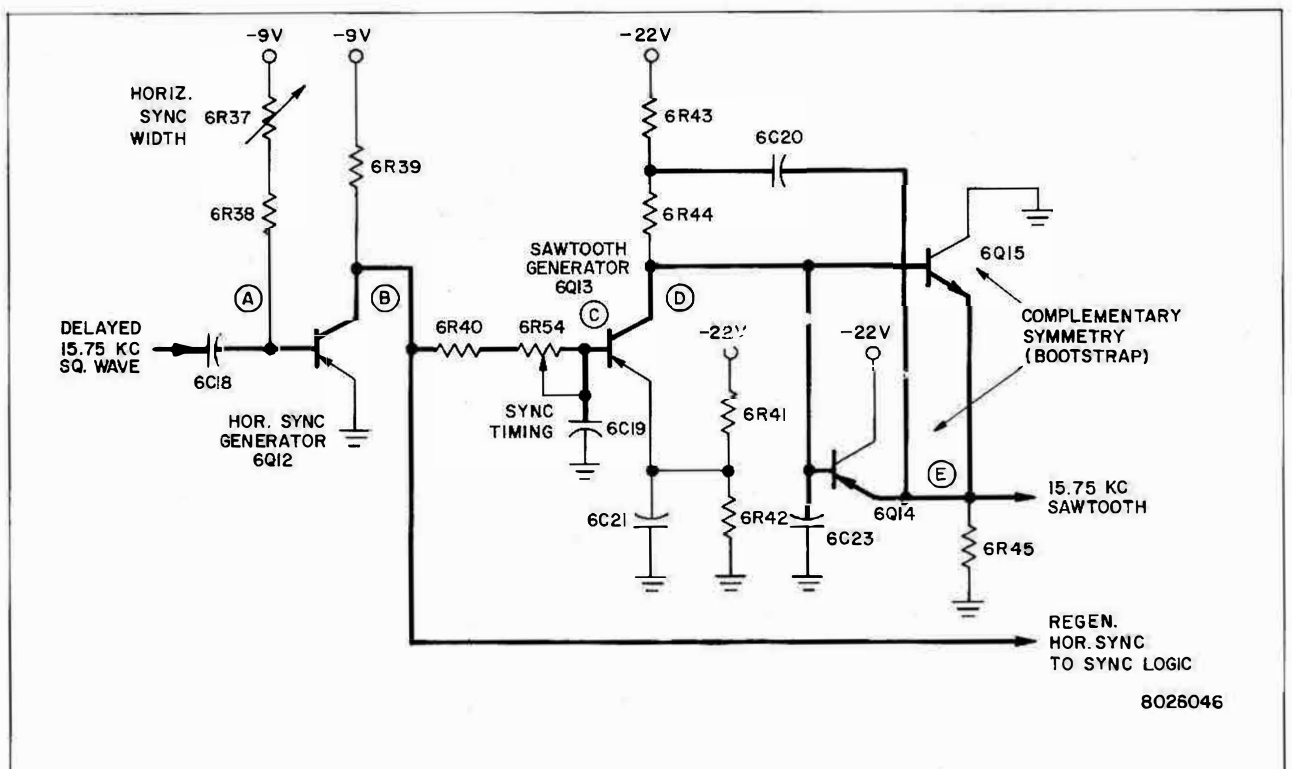
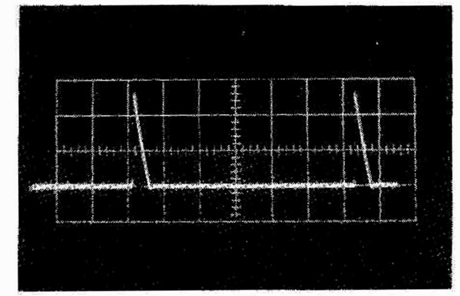
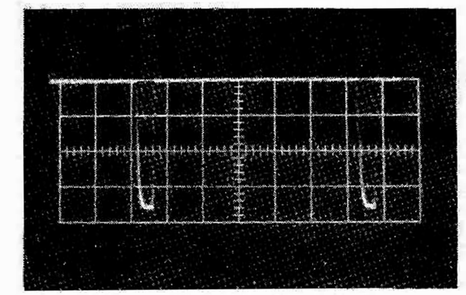


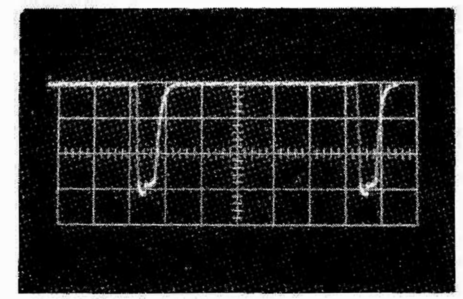
Figure SPA-18. Simplified Schematic of Horizontal Sync and Sawtooth Generator Section



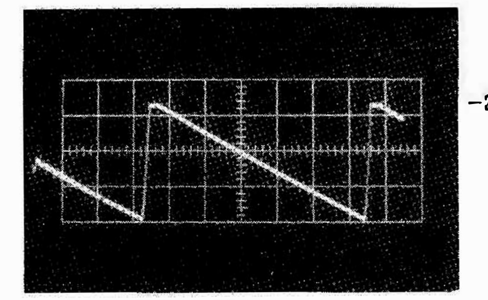
A. Base of 6Q12 at 10 microseconds/cm; 2v/division.



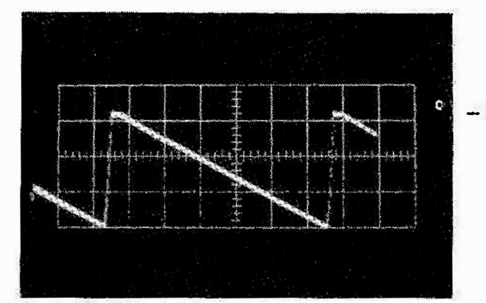
B. Collector of 6Q12 at 10 microseconds/cm; 2v/division.



C. Base of 6Q13 at 10 microseconds/cm; 1v/division.



D. Collector of 6Q13 at 10 microseconds/cm; 5v/division.



E. Emitter of 6Q14 at 10 microseconds/cm; 5v/division.

shown in figure SPA-19 provides only 15.75 kc pulses for the clamp generator 6Q5.

Separated sync is fed to the base of 6Q7 through the differentiating capacitor 6C13. Normally 6Q7 is cut off but the negative spike from the differentiation of the leading edge of the sync pulse drives the sawtooth generator into conduction. During conduction, the capacitor 6C12 discharges very rapidly through the transistor. As soon as the negative spike passes, 6Q7 cuts off again and 6C12 charges slowly through 6R23. The clipper transistor 6Q6 conducts as soon as 6C12 charges to −9 volts, the potential on the emitter, and is cut off when 6C12 is discharged at the leading edge

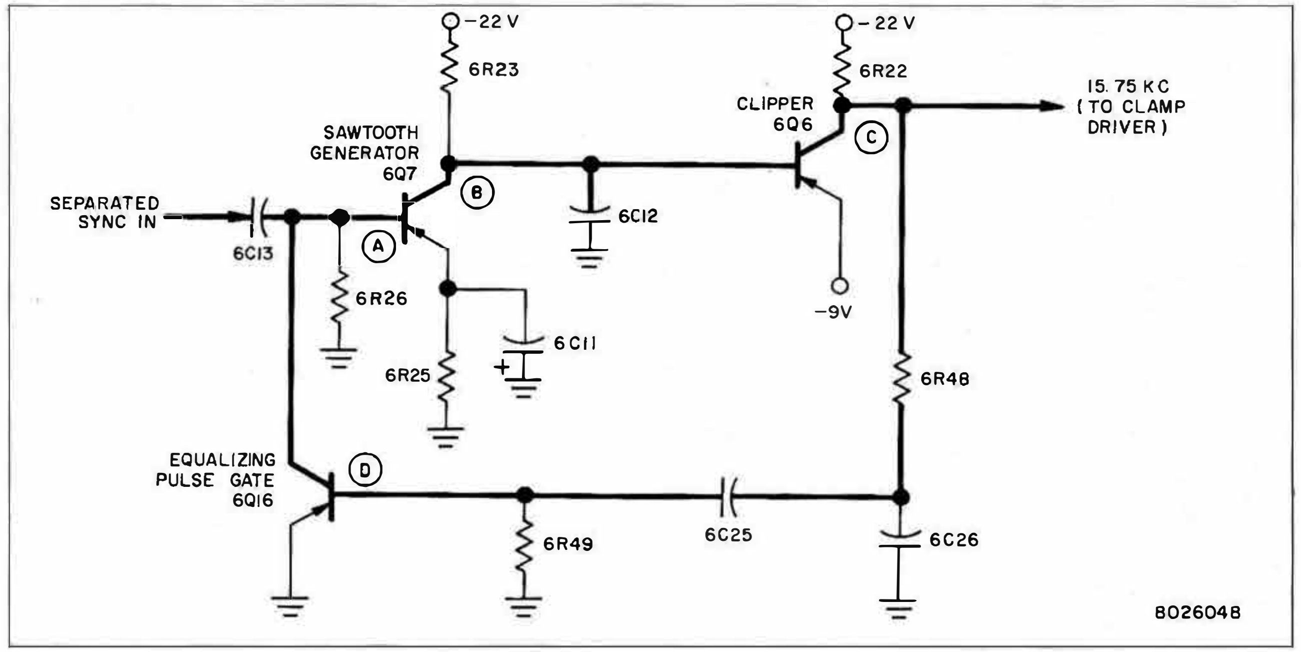
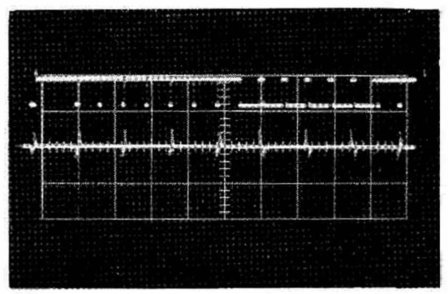
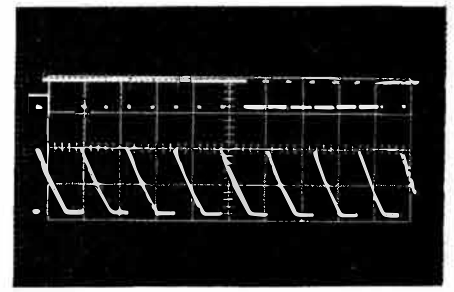


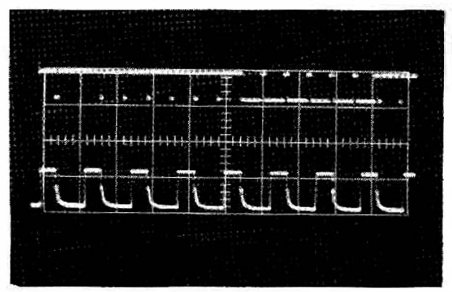
Figure SPA-19. Simplified Schematic of Double Frequency Elimination



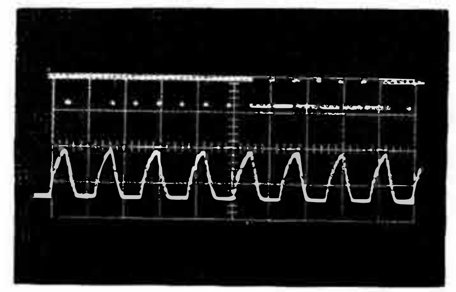
A. Base of 6Q7 at 50 microseconds/cm; 5v/division.



B. Collector of 6Q7 at 50 microseconds/cm; 5v/division.



C. Collector of 6Q6 at 50 microseconds/cm; 10v/division.



D. Base of 6Q16 at 50 microseconds/cm; 2v/division.

NOTE: Input SEP. SYNC used as timing reference for these waveforms.

of sync. The negative going signal at the collector of 6Q6, when it cuts off, is used to trigger the clamp driver transistor and is also coupled through the integrating network, 6R48 and 6C26 to the gate transistor 6Q16 which is held to cut off during the horizontal sync pulse. The time constant of the integrating network is such that the voltage drops to 0 volts prior to the time of arrival of any half line information which may be present. When the base potential drops to 0 volts, 6Q16 conducts providing a short circuit to the input signal and remains conducting until the base voltage rises above 0 volts. The time cycle required to accomplish this functioning of the gate circuit is dependent upon the time constant of 6R23 and 6C12 in the sawtooth generator and is designed to occur after the half line information passes. When 6Q16 is conducting, the half line information is shorted to ground; when 6Q16 is cut off, the 15.75 kc information is coupled to 6Q7.

As shown in figure SPA-20, the 15.75 kc signal from the collector of 6Q6 is coupled to the clamp pulse generator 6Q5. Transistor 6Q5 is a boxcar* circuit which generates a narrow pulse; the leading edge of this pulse corresponds in time to the leading edge of sync. The positive pulse at the collector of 6Q5 is direct-coupled to the base of the clamp driver 6Q4.

In the clamp driver circuit, a negative pulse from the collector and a positive pulse from the emitter apply forward bias to all four diodes simultaneously. At the tips of the pulses, the diodes conduct momentarily connecting the sawtooth voltage to capacitor 6C7 which acts as a memory device, storing the instantaneous voltage of the sawtooth at the moment of connection. During the remainder of the horizontal period, the diodes are reverse biased and 6C7 remains at the clamped voltage which sets the operating point for AFC current amplifier 6Q3 supplying the AFC bias to the master oscillator.

If the incoming separated sync signal changes frequency or phase slightly, the clamp pulse derived from it occurs at a slightly different time relative to the sawtooth voltage applied to the detector 6Z1. Therefore there is a change in the instantaneous voltage to which 6C7 charges. This change causes the AFC bias to bring the frequency and phase of the master oscillator to correspond with that of the incoming signal. When the AFC loop is operating properly, sampling of the sawtooth voltage takes place on the fast positive-going portion of the sawtooth.

* See Basic Circuit Descriptions on p. SPA-48.

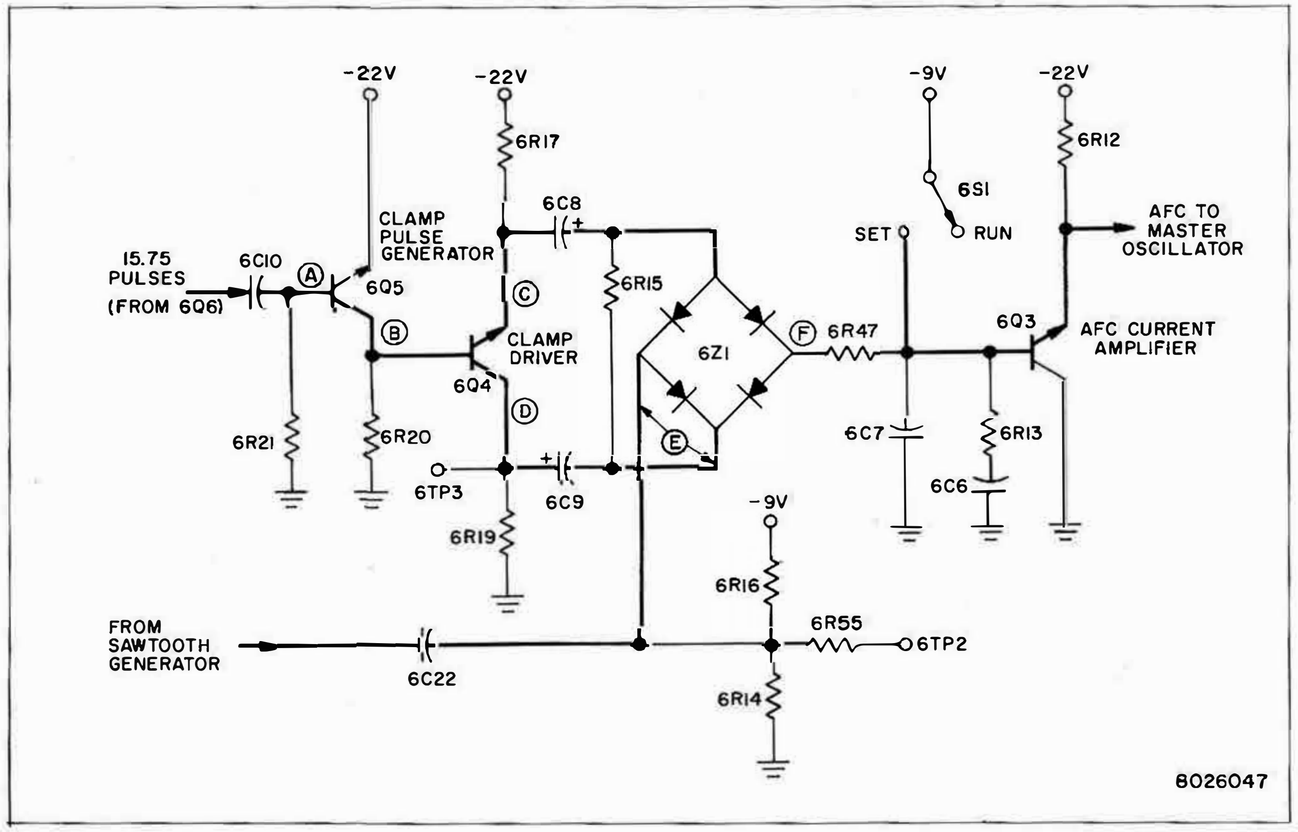
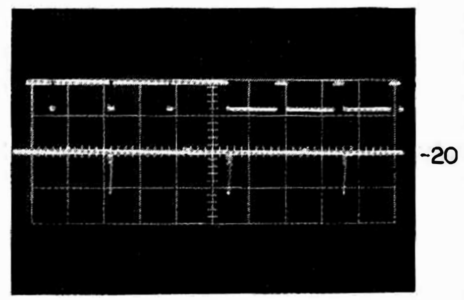
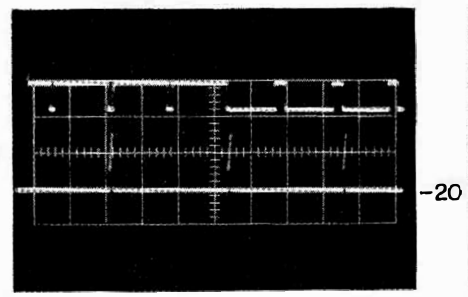


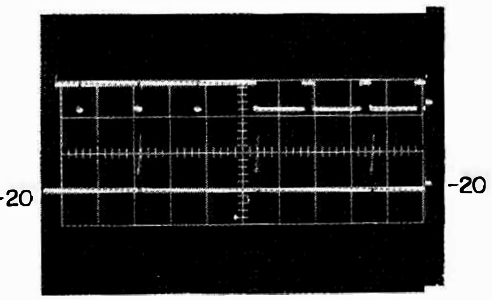
Figure SPA-20. Simplified Schematic of Phase Detector Section



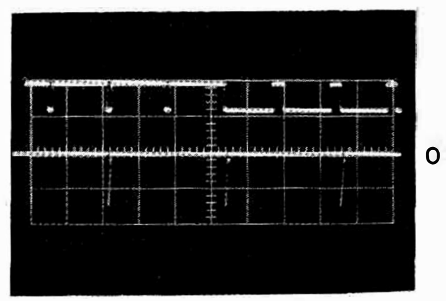
A. Base of 6Q5 at 20 microseconds/cm; 2v/division.



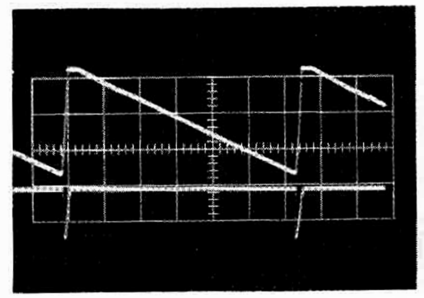
B. Collector of 6Q5 at 20 microseconds/cm; 10v/division.



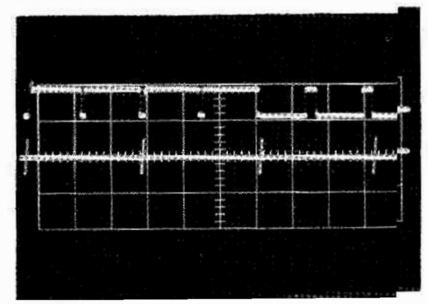
C. Emitter of 6Q4 at 20 microseconds/cm; 10v/division.



D. Collector of 6Q4 at 20 microseconds/cm; 10v/division.



E. Test Points 6TP2 and 6TP3 at 10 microseconds/cm; 5v and 10v/division.



F. Clamp 6Z1 at 20 microseconds/cm; 10v/division.

NOTE: Input SEP. SYNC used as timing reference for these waveforms (except E.).

b. VERTICAL ADVANCE MODULE.

(Refer to Block Diagram Figure SPA-21.)

The Vertical Advance Module is required to produce the timing edge which determines the leading edge of vertical blanking and the 9H gating pulse. The method of vertical-pulse advance used must regenerate the vertical blanking edge, which precedes the vertical sync signal by 3H. The technique used to obtain vertical advance is that of counting horizontal pulses between adjacent vertical intervals. The counters are designed to follow any change in basic sync frequency and automatically readjust the position of vertical blanking. More over, they recover quickly from transient disturbances in the recording system.

Timing Chart

In the timing chart, figure SPA-22, the relative positions of the vertical blanking edge, equalizing pulses and vertical sync interval are shown. The leading edge of the second vertical sync pulse is the earliest possible time for detecting accurately the position of vertical sync. Although the timing difference between vertical blanking and vertical sync is 3H, observe on the timing chart that the difference between the two edges—vertical blanking and vertical pulse position—is actually 3.5H. This timing distance of 3.5H must be maintained to produce vertical blanking from vertical sync. The timing distance of 3.5H is exactly the period of a ÷7MV counter running from a 31.5 kc master oscillator. The vertical advance circuits must, therefore, select that one period of the ÷7MV (one out of the 75 periods which occur in each field) which is so phased that the beginning of the period falls on the leading edge of vertical blanking and the end of the period falls 3.5H later in vertical sync.

As shown in figure SPA-21, the 31.5 kc pulses supplied through the trigger gating circuits, 8Q12 and 8Q13, activate a string of counters. The count is initiated by the start pulse which is generated from the vertical sync in the Sync Logic Module. The counters count for 259 lines then shut off due to the coincidence of the last three counters (÷5, ÷5, ÷3) and normally remain shut off for a period of 3.5H. This period of 3.5H added to 259H equals 262.5 lines or one field. The next cycle is started by the generation of another START pulse from the Sync Logic Module. Under unusual operating conditions due to a non-synchronous switch or a bad splice in the tape, the vertical sync period of the separated sync signal may arrive at a much later time. In this event, the counters remain off until a new start pulse is generated when vertical sync does arrive.

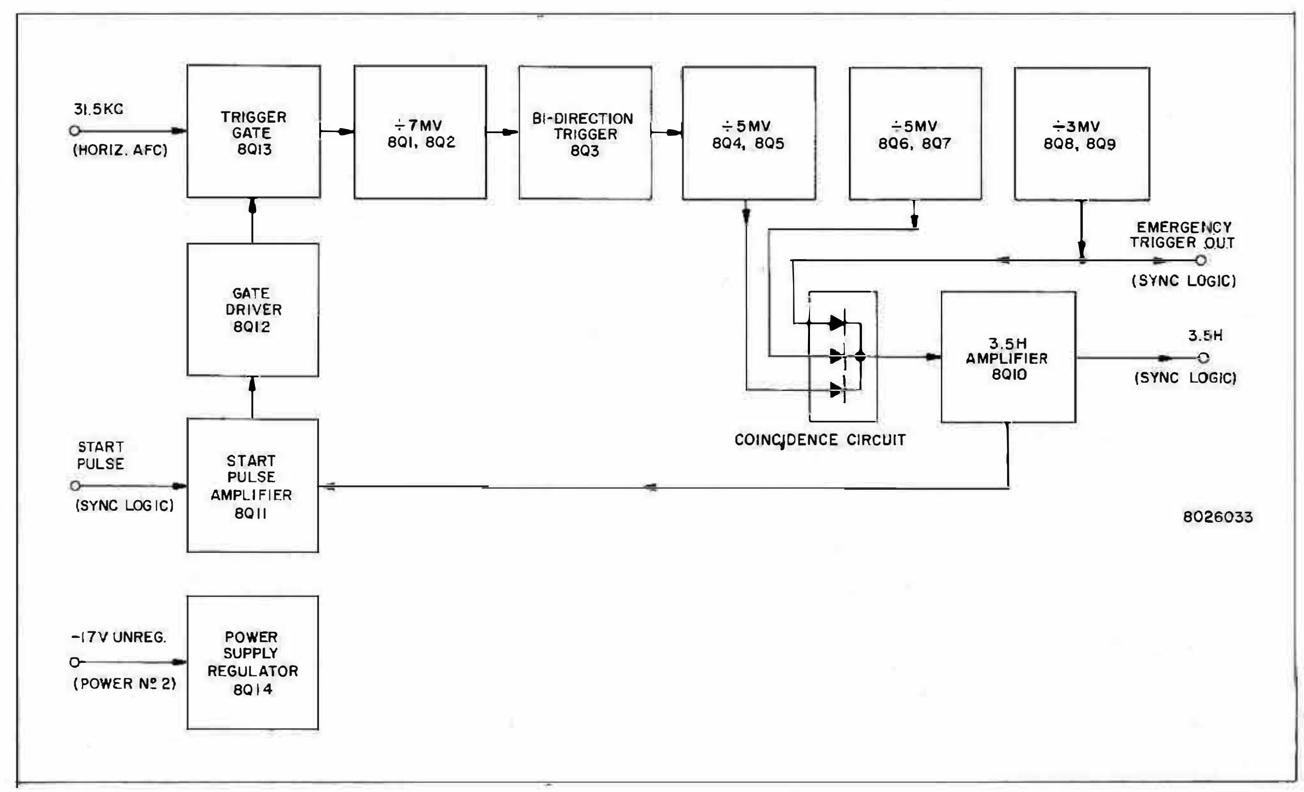
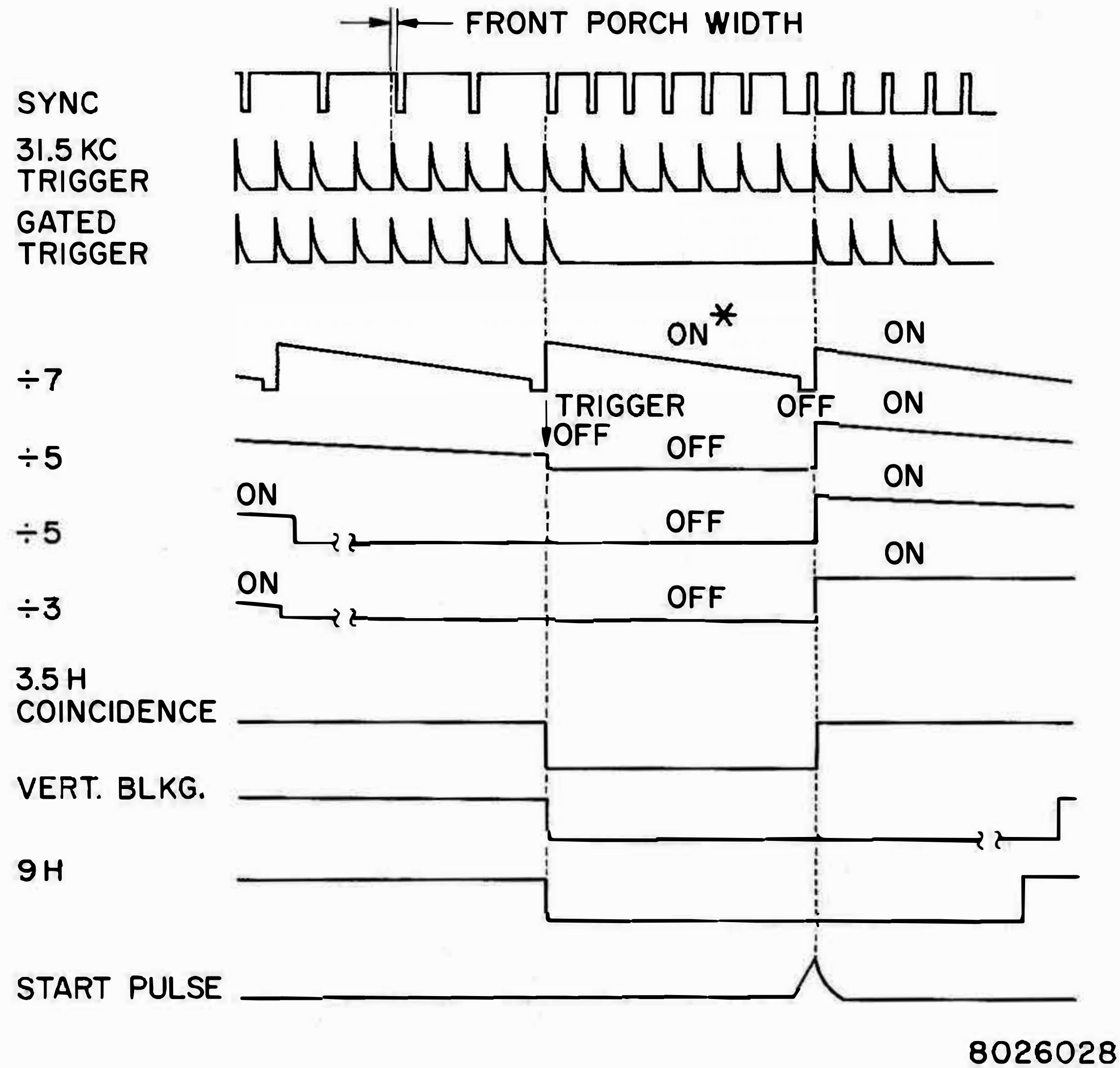


Figure SPA-21. Block Diagram of Vertical Advance Module



NOTE: ON refers to active counting time; OFF refers to resting time of counters. Conducting state of transistors (ON — OFF) is opposite to that of the counters.

Figure SPA-22. Pulse Timing Chart

Gating Circuits

As shown in the simplified schematic, figure SPA-23, the 31.5 kc input pulses from the Horizontal AFC Module are applied to the base of 8Q13 through the differentiating network 8C16 and 8R45. Transistor 8Q13 is an emitter follower which clips the negative spike from the differentiated pulse. The trigger pulses from the emitter of 8Q13 are coupled to the counter chain through the isolation diode 8CR8.

The 31.5 kc pulses are gated by 8Q12 the gate driver which is driven to saturation during the 3.5H interval, shorting out the pulses. At all other times, 8Q12 is biased off, allowing the pulses to pass to the counter chain. The 3.5H pulse driving 8Q12 is coupled to its base from the collector of 8Q11, the start pulse amplifier. Transistor 8Q11 is also normally biased off because its base is held to approximately 0 volts, the potential on the anode of 8CR6. During the 3.5H pulse interval, the anode voltage of 8CR6 drops to −9 volts, allowing the base of 8Q11 to fall to the potential determined by the bias network of 8R39, 8R40 and 8R44. In this state, 8Q11 conducts and drives 8Q12 to saturation. Transistors 8Q11 and 8Q12 remain conducting until a positive start pulse drives 8Q11 off which in turn drives 8Q12 off. This allows a 31.5 kc trigger to pass, starting the counters which terminates the 3.5H pulse. The base of 8Q11 is again held to 0 volts and does not conduct.

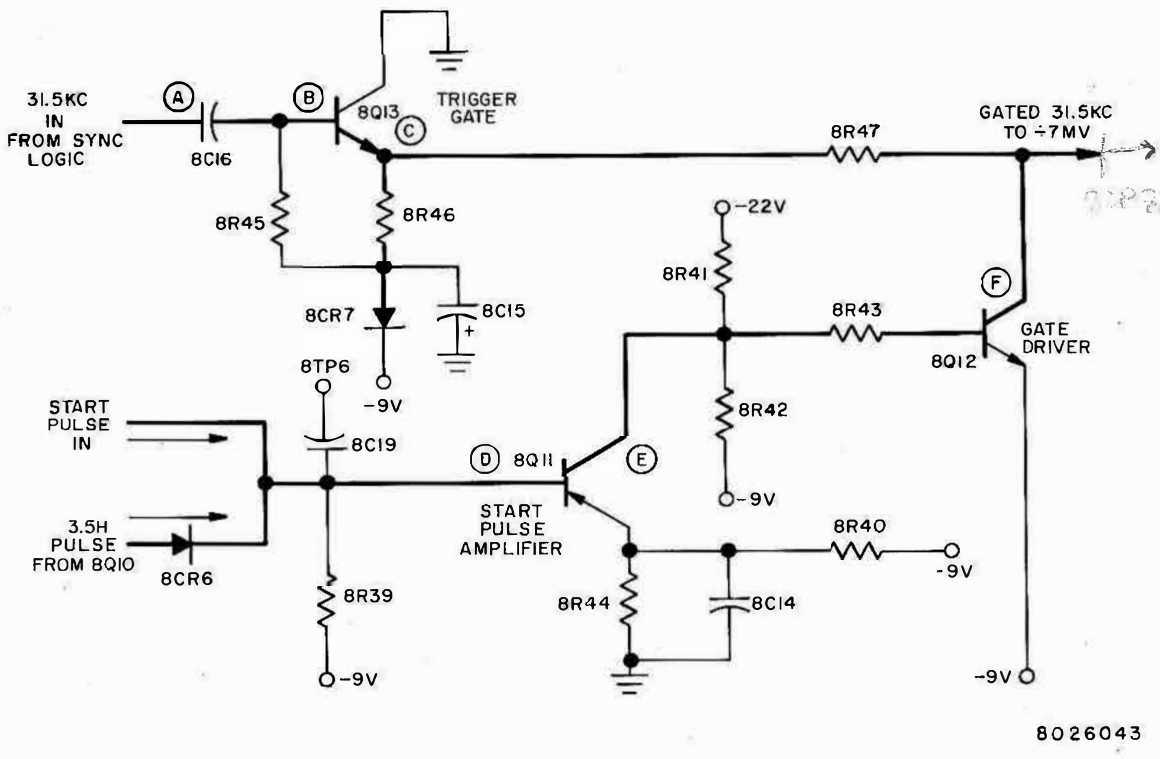
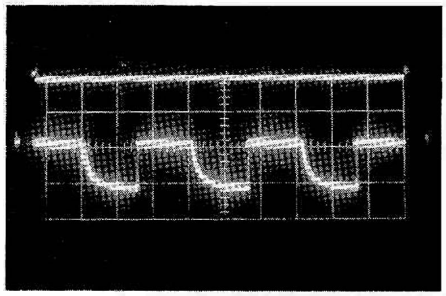
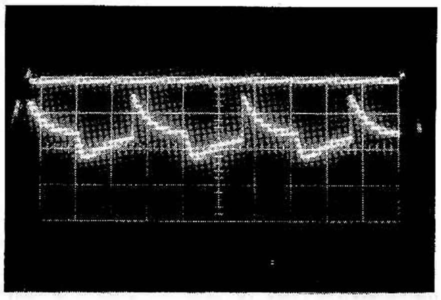


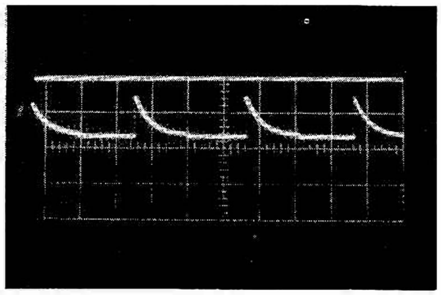
Figure SPA-23. Simplified Schematic of 31.5 KC Trigger Gating Circuits



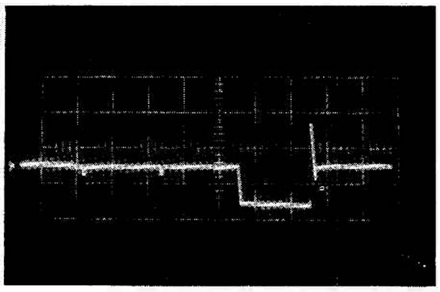
A. 31.5KC IN, 8J8-1 at 10 micro-seconds/cm; 5v/division.



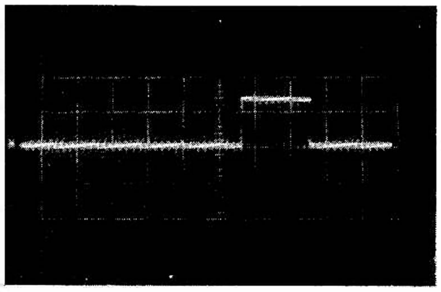
B. Base of 8Q13 at 10 micro-seconds/cm; 5v/division.



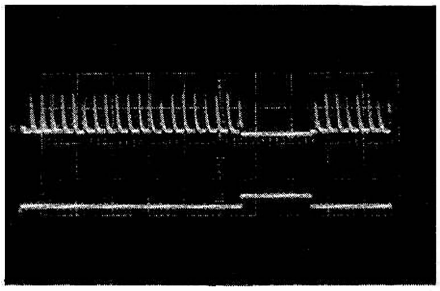
C. Emitter of 8Q13 at 10 micro-seconds/cm; 5v/division.



D. Base of 8Q11 at 100 micro-seconds/cm; 2v/division.



E. Collector of 8Q11 at 100 micro-seconds/cm; 2v/division.



F. Top: Collector of 8Q12 at 100 micro-seconds/cm; 5v/division.
Bottom: Base of 8Q12 at 100 micro-seconds/cm; 5v/division.

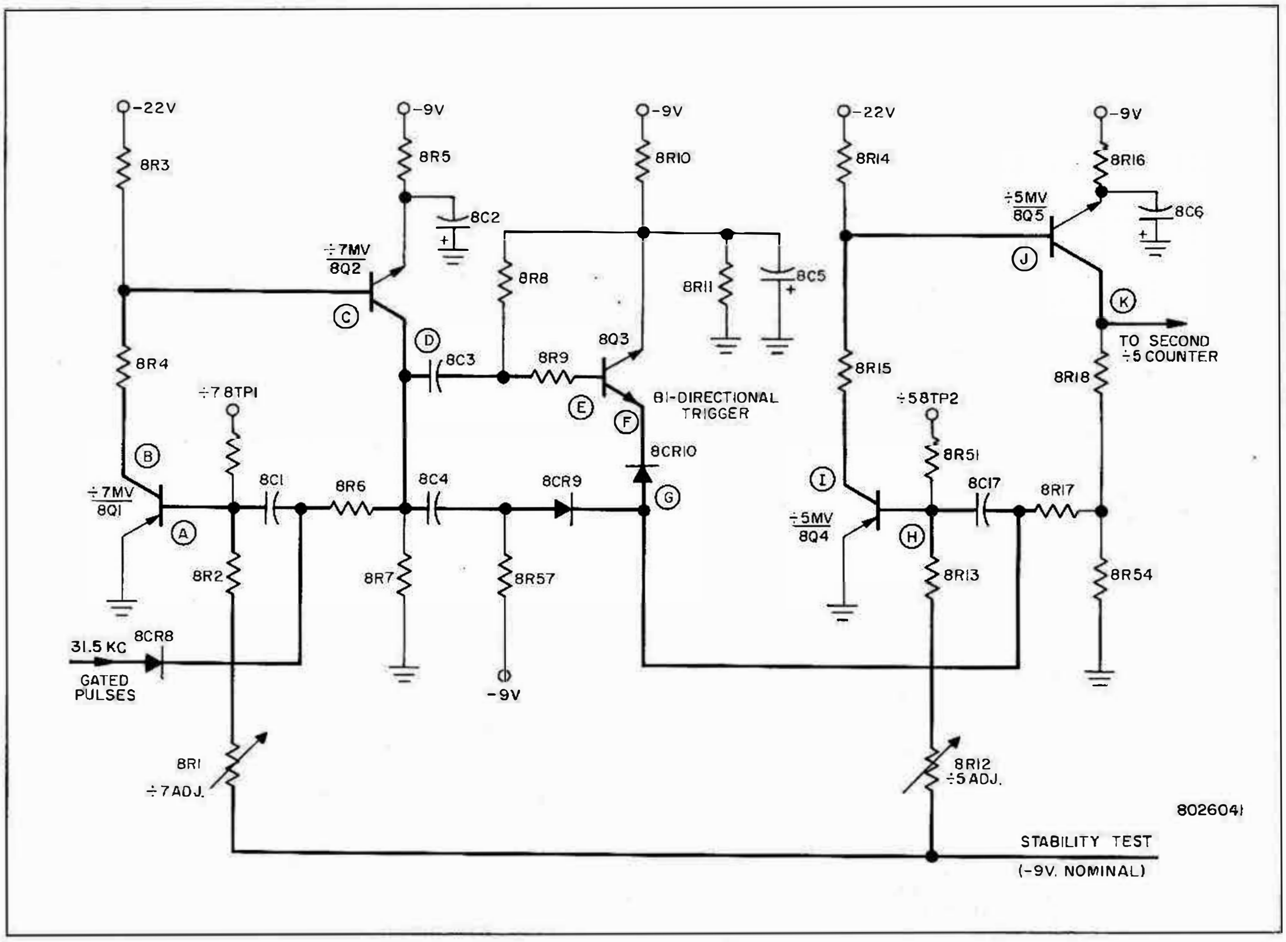


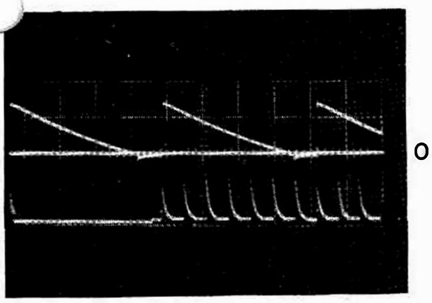
Figure SPA-24. Simplified Schematic of Counter Stages ÷7 and ÷5

Counters

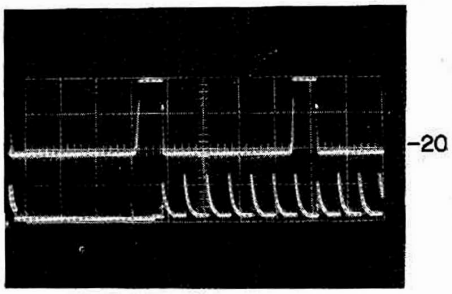
As shown in figure SPA-24, the first counter, the ÷7MV, is a monostable multivibrator similar in design to the ÷2MV in the Horizontal AFC Module. Both transistors 8Q1 and 8Q2, conduct in the stable state. When the base is driven positive by the first pulse, the transistor 8Q1 is driven to cut off (also cutting off 8Q2). Time constant 8C1, 8R1 and 8R2 determine the length of time the multivibrator is cut off. The transistor must return to the stable conducting state just after the seventh pulse.

The operation of the ÷5 multivibrator is similar to that of the ÷7 multivibrator. However, the conducting time of the transistors is not entirely dependent on the time constant of 8C17, 8R12 and 8R13. Variations in component values and transistor characteristics cause slight variations in timing. Since one of the conduction times of the multivibrator is the 3.5H pulse, precise timing is essential for both on and off transitions. This is accomplished by using the triggers not only to start but also to stop the timing cycle.

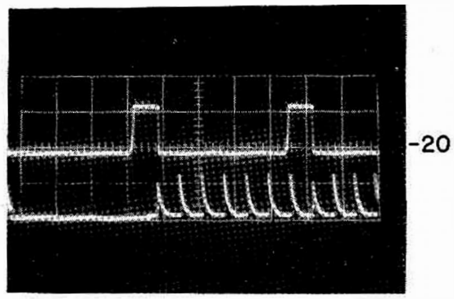
The positive and negative trigger pulses required to start and stop the ÷5 counter are generated by the bidirectional trigger 8Q3 in conjunction with the diodes 8CR9 and 8CR10. Transistor 8Q3 is a bilateral transistor, that is, either electrode may be used as the emitter or collector. As shown in figure SPA-24, the collector is DC-connected through 8CR10 to the junction of 8R18 and 8R54 in the collector circuit of 8Q5. In the stable state of the multivibrator, when 8Q5 is conducting, the voltage at the junction of 8R18 and 8R54 is almost —9 volts, and 8Q3 does not conduct since the emitter and collector of the 8Q3 transistor are at the same potential. However, a positive spike resulting from the differentiation of the ÷7 pulse is passed by 8CR9 through 8C17 to the base of 8Q4. The positive spike cuts off 8Q4 and 8Q5, and the voltage at 8R18 and 8R54 rises to 0 volts. In this condition 8CR9 is reverse-biased and does not pass the positive spikes. Now, however, the collector-to-emitter voltage of 8Q3 is sufficient to provide amplification of the positive spikes fed to its base. The resulting negative trigger pulses at the collector of 8Q3 are passed through 8CR10 and 8C17 to the base of 8Q4. On the fifth count, 8Q4 and 8Q5 are driven into conduction, and the cycle repeats.



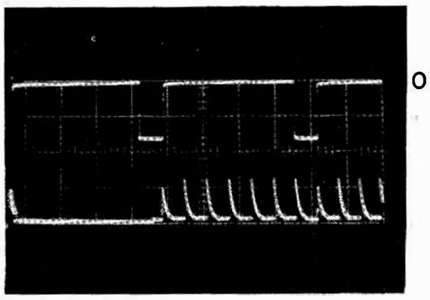
A. Top: Base of 8Q1 at 50 micro-seconds/cm; 5v/division.
Bottom: Gated 31.5 KC



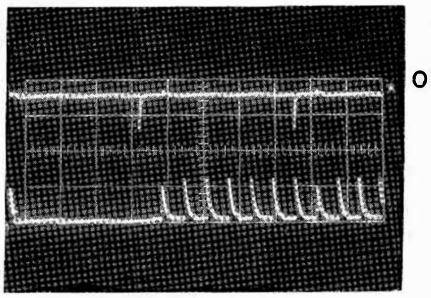
B. Top: Collector of 8Q1 at 50 micro-seconds/cm; 10v/division.
Bottom: Gated 31.5 KC.



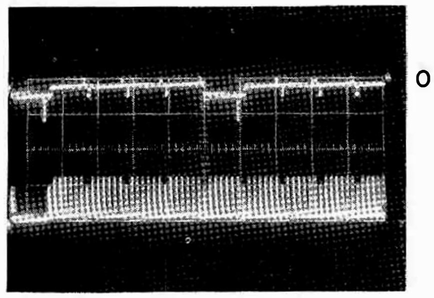
C. Top: Base of 8Q2 at 50 micro-seconds/cm; 10v/division.
Bottom: Gated 31.5 KC.



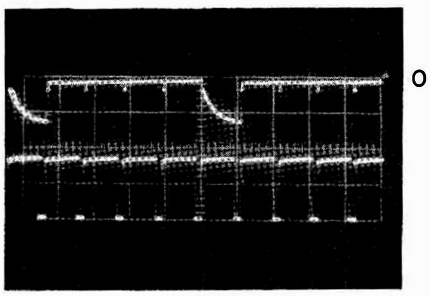
D. Top: Collector of 8Q2 at 50 imcro-seconds/cm; 5v/division.
Bottom: Gated 31.5 KC.



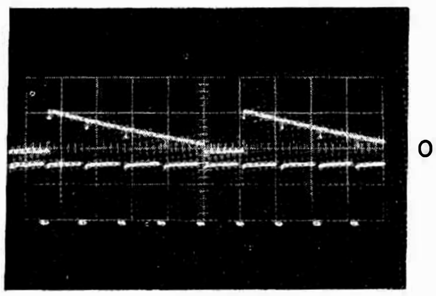
E. Top: Base of 8Q3 at 50 micro-seconds/cm; 5v/division.
Bottom: Gated 31.5 KC.



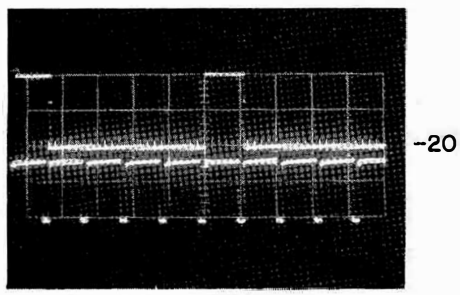
F. Top: Collector of 8Q3 at 200 micro-seconds/cm; 5v/division.
Bottom: Gated 31.5 KC.



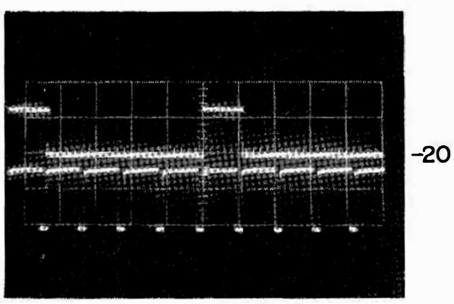
G. Top: Anode of 8CR10 at 200 micro-seconds/cm; 5v/division.
Bottom: ÷7 (8Q2-C).



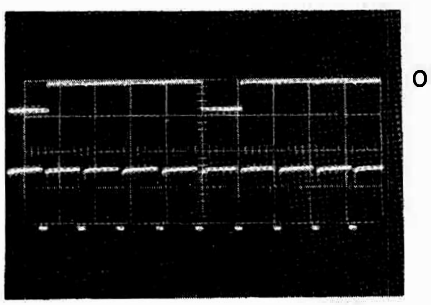
H. Top: Base of 8Q4 at 200 micro-seconds/cm; 5v/division.
Bottom: ÷7 (8Q2-C).



I. Top: Collector of 8Q4 at 200 micro-seconds/cm; 10v/division.
Bottom: ÷7 (8Q2-C).



J. Top: Base of 8Q5 at 200 micro-seconds/cm; 10v/division.
Bottom: ÷7 (8Q2-C).



K. Top: Collector of 8Q5 at 200 micro-seconds/cm; 10v/division.
Bottom: ÷7 (8Q2-C).

As shown in figure SPA-25, the final two counters, ÷5MV and ÷3MV are identical in operation to the ÷7MV. Each multivibrator conducts in the stable state; each is cut off by the positive spike resulting from the differentiating of the trailing edge of the preceding pulse output. The trailing edge of the ÷3 counter pulse is used as an emergency trigger for the vertical blanking generator multivibrator in the Sync Logic Module.

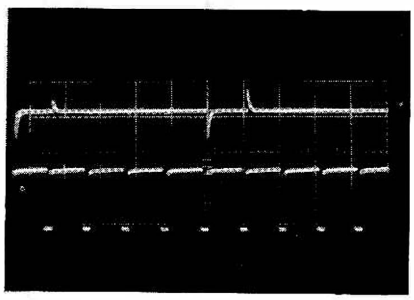
Coincidence Gate

The coincidence gate consists of the diodes 8CR3, 8CR4, 8CR5. The cathode of each diode is connected to −9v through resistor 8R37. The anode of each diode is connected to the collector of the output transistor of each of the last three counter multivibrators, ÷5MV, ÷5MV and ÷3MV. When any one of these multivibrators is in the non-conducting (counting) state, its collector is at 0 volts, and the corresponding diode connected to its collector conducts, holding the base of the 3.5H amplifier 8Q10 close to 0 volts, causing the amplifier to conduct. However, if none of these multivibrators is counting, a condition which occurs 259H from the start of the counter cycle, none of the diodes conducts. The base of 8Q10 then drops to −9 volts and the transistor is cut off. The emitter of 8Q10 is normally at 0 volts when the transistor is conducting, providing the holding voltage for the anode of 8CR6 of the trigger gating circuits. During the 3.5H period of coincidence, this voltage drops to −9 volts.

Stability Test

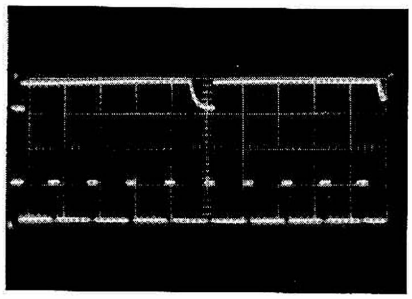
The stability test circuit shown in figure SPA-25 provides a temporary variation in the power supply voltage to ensure that the counters have been set approximately in the middle of the range in which they provide the proper count. If one or more of the counters has been set too near the edge of its range, it will miscount when the STABILITY TEST button is pressed and the potentiometer is varied. Refer to the *Maintenance* section for the procedure to readjust the range of each counter when necessary.

As shown in the overall schematic diagram figure SPA-48, one more circuit—a regulator—appears in this module. This regulator isolates the large current surges on the Vertical Advance Module from the remainder of the Signal Processing Amplifier. Transistor 8Q14 also provides a low-impedance power source for the Vertical Advance Module.



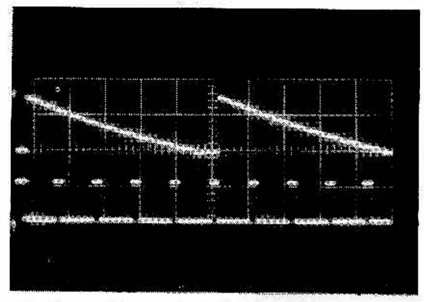
−10

A. Top: Anode of 8CR1 at 200 microseconds/cm; 10v/division. Bottom: ÷7 (8Q2-C).



0

B. Top: Cathode of 8CR1 at 1000 microseconds/cm; 10v/division Bottom: ÷5 (8Q4-C).



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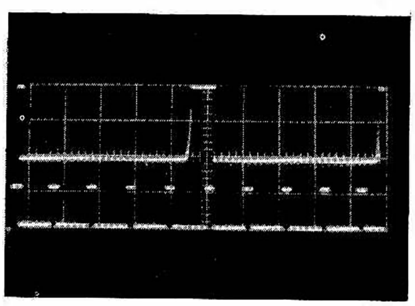
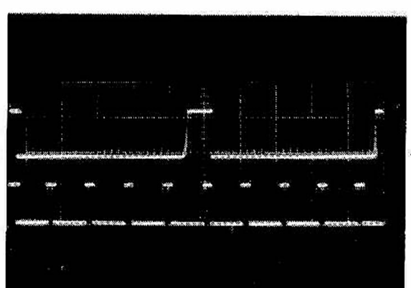
C. Top: Base of 8Q6 at 1000 microseconds/cm; 5v/division. Bottom: ÷5 (8Q4-C).



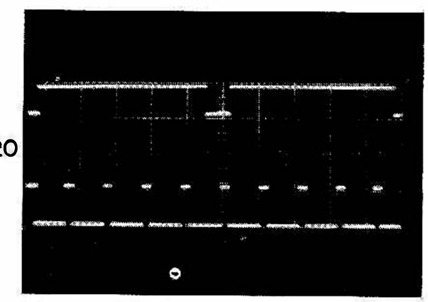
−20

D. Top: Collector of 8Q6 at 1000 microseconds/cm; 10v/division. Bottom: ÷5 (8Q4-C).



−20

E. Top: Base of 8Q7 at 1000 microseconds/cm; 10v/division. Bottom: ÷5 (8Q4-C).



0

F. Top: Collector of 8Q7 at 1000 microseconds/cm; 10v/division. Bottom: ÷5 (8Q4-C).

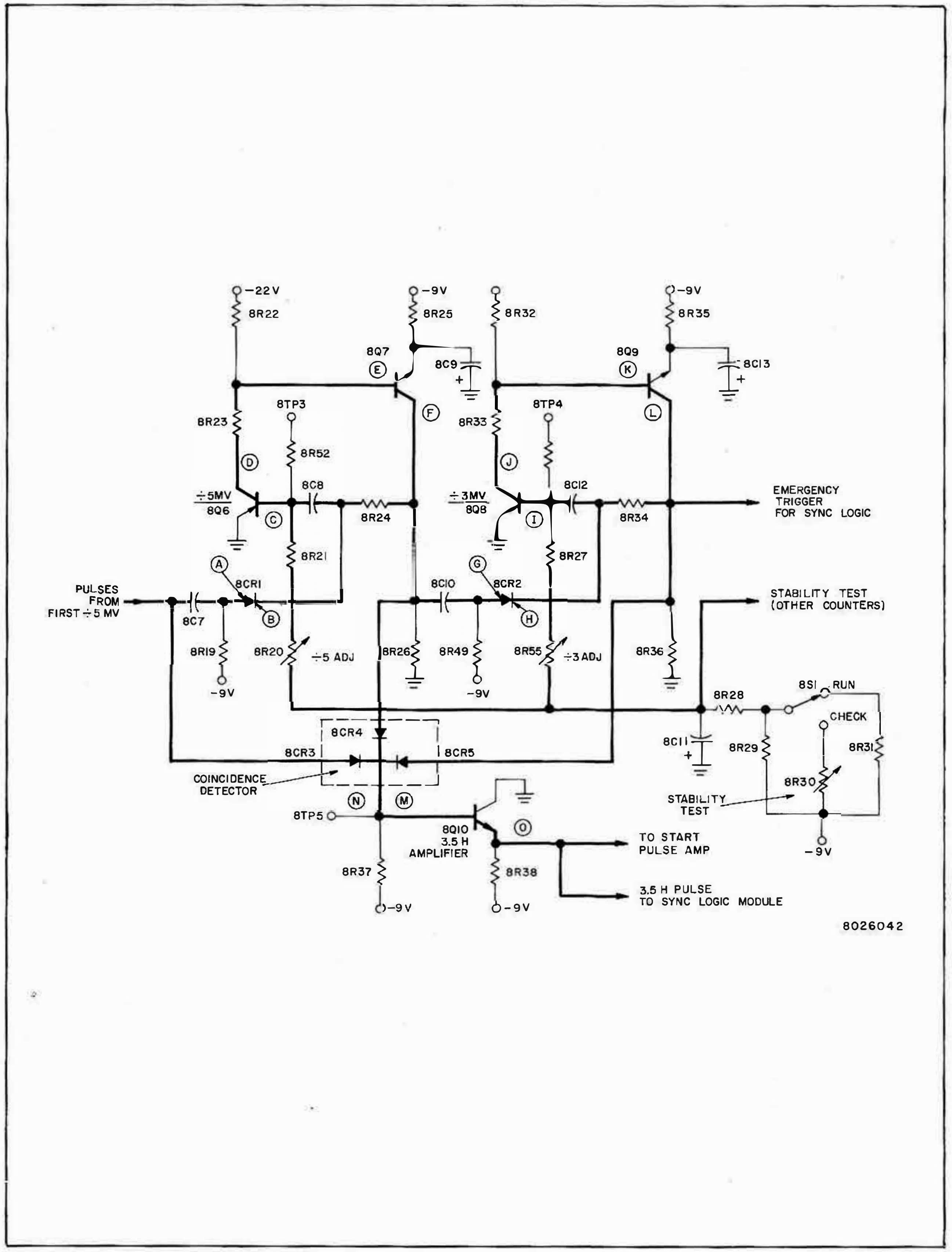
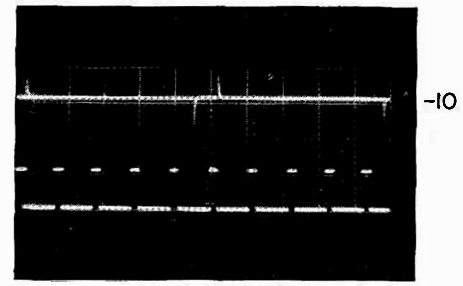
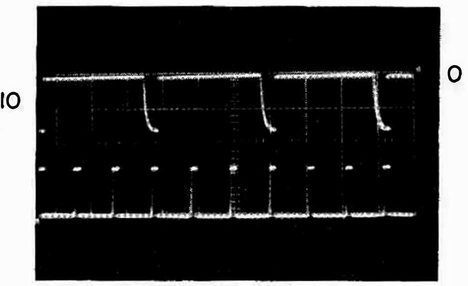


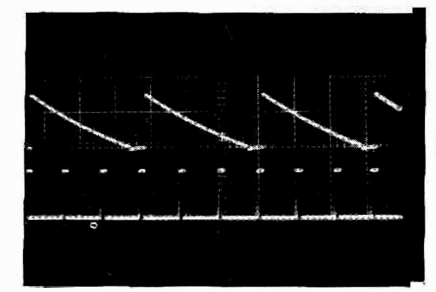
Figure SPA-25. Simplified Schematic of Counter Stages Second ÷5, ÷3, and Coincidence Detector



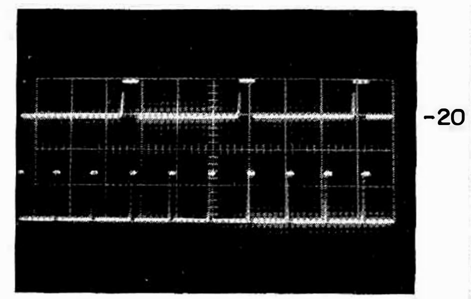
G. Top: Anode of 8CR2 at 1000 microseconds/cm; 10v/division. Bottom: ÷5 (8Q4-C).



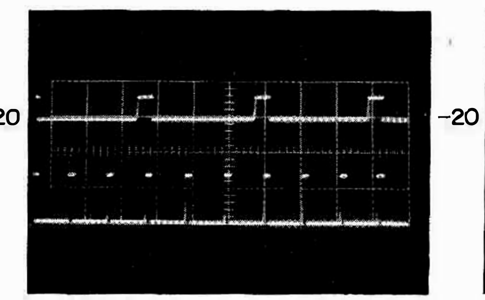
H. Top: Cathode of 8CR2 at 5000 microseconds/cm; 5v/division. Bottom: ÷5 (8Q7-B).



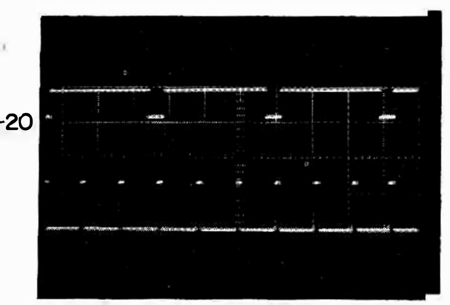
I. Top: Base of 8Q8 at 5000 microseconds/cm; 5v/division. Bottom: ÷5 (8Q7-B).



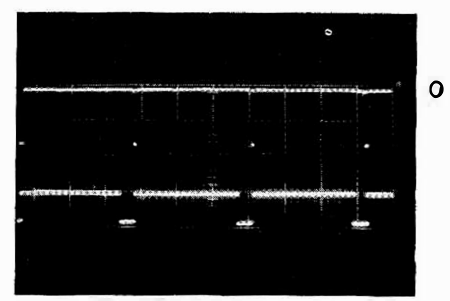
J. Top: Collector of 8Q8 at 5000 microseconds/cm; 20v/division. Bottom: ÷5 (8Q7-B).



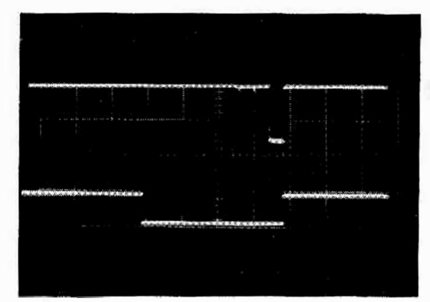
K. Top: Base of 8Q9 at 5000 microseconds/cm; 20v/division. Bottom: ÷5 (8Q7-B).



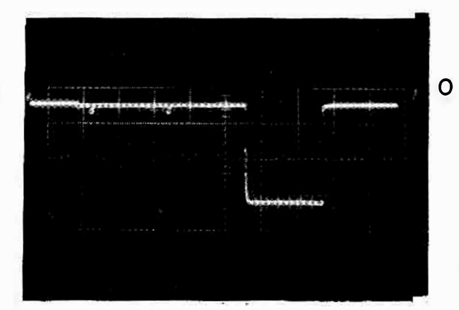
L. Top: Collector of 8Q9 at 5000 microseconds/cm; 10v/division. Bottom: ÷5 (8Q7-B).



M. Top: Base of 8Q10 at 5000 microseconds/cm; 5v/division. Bottom: ÷3 (8Q9-C).



N. Top: Base of 8Q10 at 500 microseconds/cm; 10v/division. Bottom: ÷3 (8Q9-C).



O. Emitter of 8Q10 at 100 microseconds/cm; 2v/division.

c. SYNC LOGIC MODULE.

(Refer to Block Diagram Figure SPA-26.)

The Sync Logic Module provides signals for the operation of the other modules as well as signals for the recording system. When triggered by the leading edge of the 3.5H pulse generated in the Vertical Advance Module, the Sync Logic Module regenerates the vertical blanking and reinserts the vertical sync interval. This module also provides horizontal drive for use in the system, start pulse for use in the Vertical Advance Module, gated horizontal sync for the Input and Blanking and Color Modules, regenerated sync, and regenerated horizontal and vertical blanking for the Input and Blanking Module.

Vertical Blanking Generator

As shown in figure SPA-27, the vertical blanking multivibrator, 9Q1 and 9Q2, is a monostable multivibrator with 9Q1 ON and 9Q2 OFF in the stable state. The multivibrator changes state by applying a positive trigger pulse to the base of 9Q1 through the isolation diode 9CR1. The normal trigger pulse for the vertical blanking multivibrator is the leading edge of the 3.5H pulse. Transistor 9Q1 remains OFF and 9Q2 ON for the length of time determined by the charging time of the capacitor 9C1 through resistors 9R1 and 9R2. The vertical blanking pulse width at the collector of 9Q2 is set to 21H by adjustment of 9R1, the VERTICAL BLANKING WIDTH control.

The output of 9Q2 is coupled to the blanking mixer 9Q11 through the isolation diode 9CR13 and to the 9H generator through 9C3. The 9H generator 9Q3 is a pulse-narrowing* circuit. The 9H pulse output from the collector of 9Q3 is coupled through the isolation diode 9CR4 and combined with the 3.5H pulse input signal. The combined pulses are then passed through network 9R16 and 9C18 to the horizontal sync gate 9Q6 and through network 9R15 and 9C17 to the base of the 9H amplifier, 9Q4. An output to the vertical interval gate 9Q5 is taken from the emitter of 9Q4, the 9H amplifier.

Emergency Trigger

The normal trigger pulse for the vertical blanking multivibrator is the leading edge of the 3.5H pulse

* See Basic Circuit Descriptions on p. SPA-48.

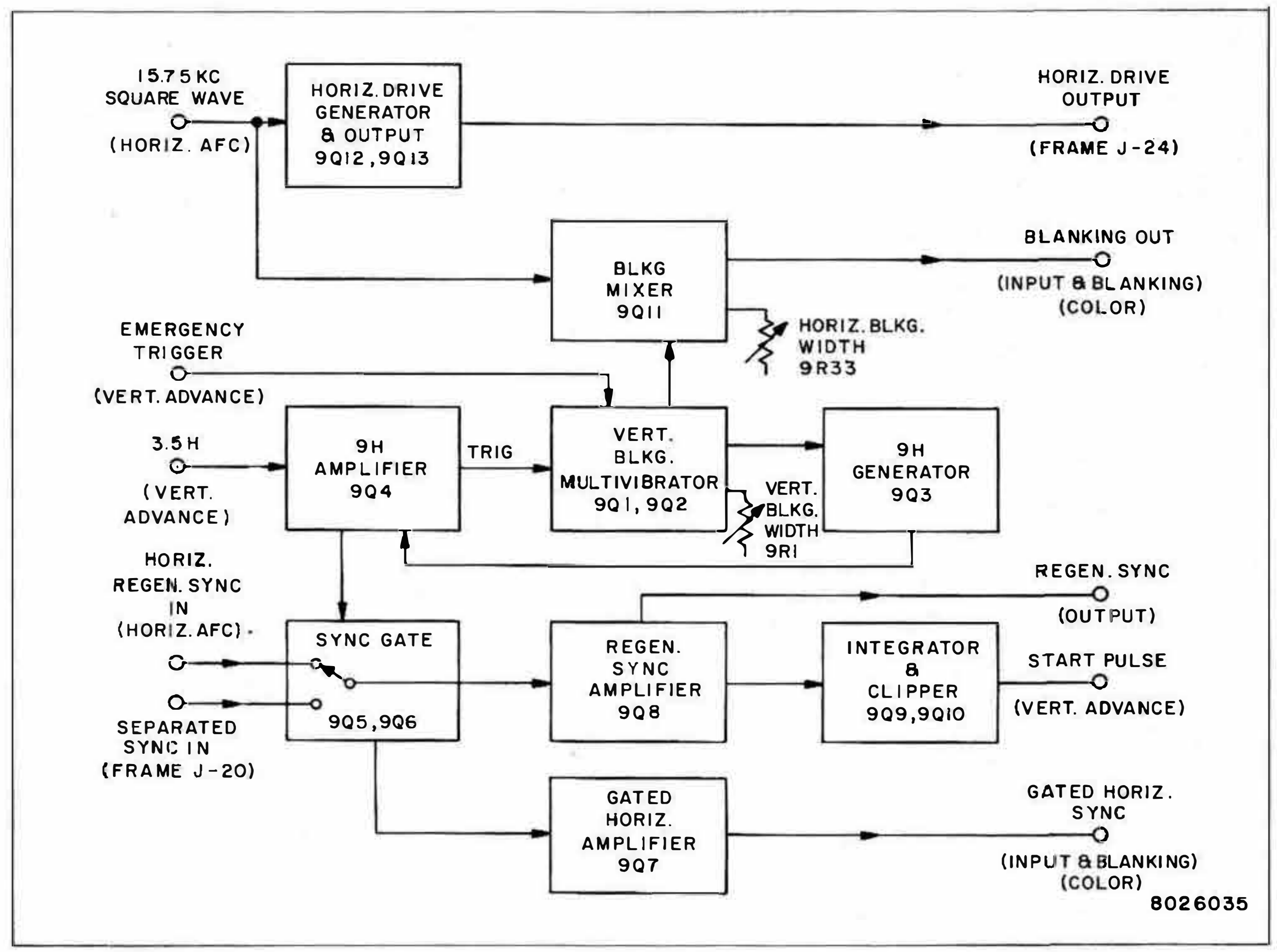


Figure SPA-26. Block Diagram of Sync Logic Module

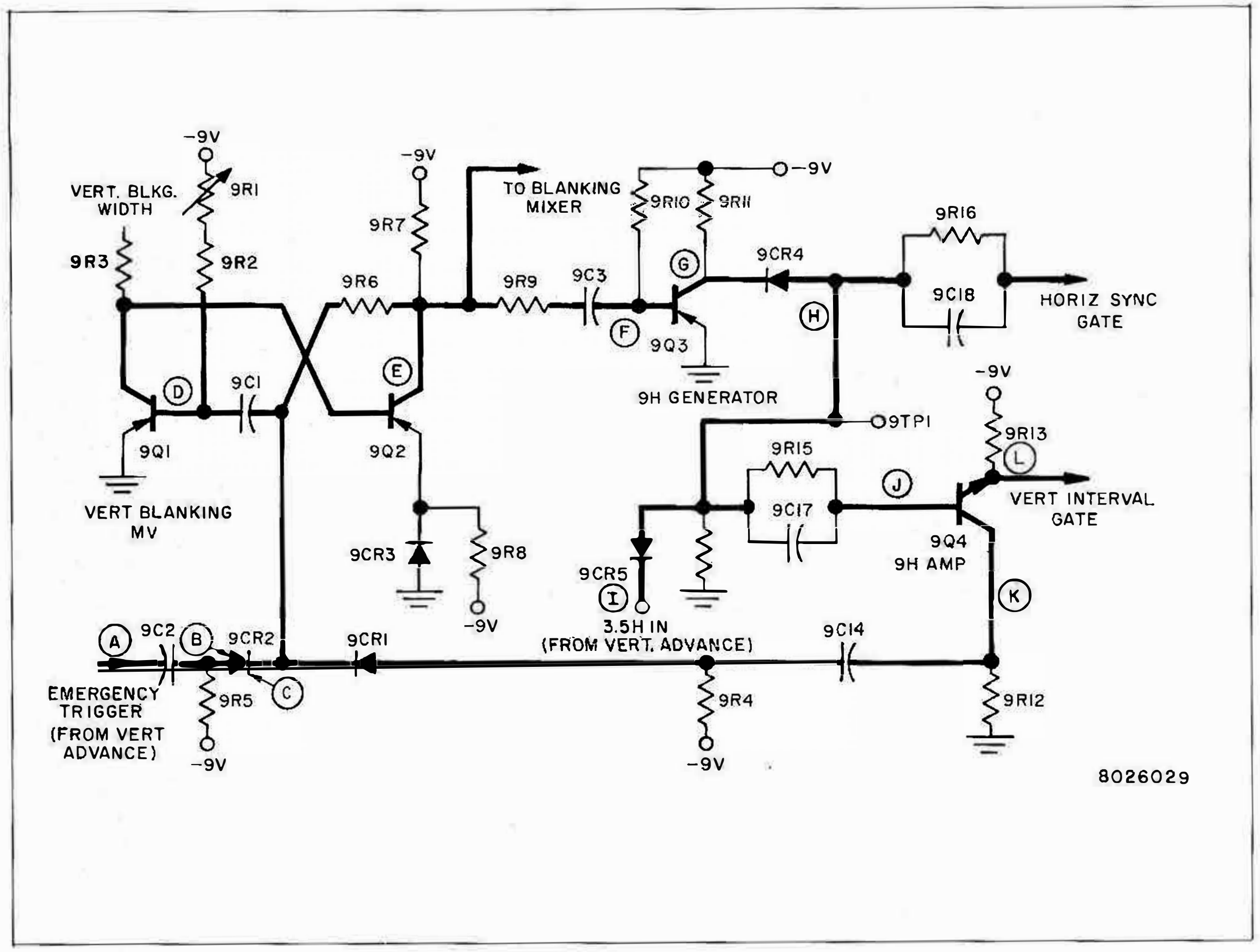
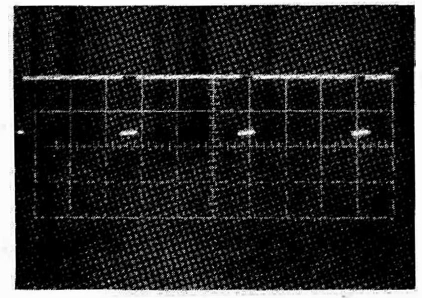
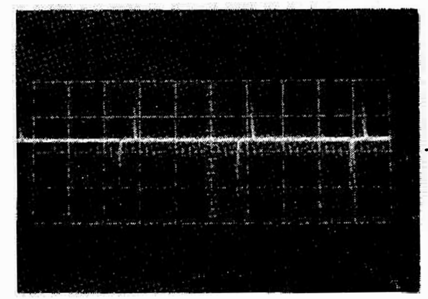


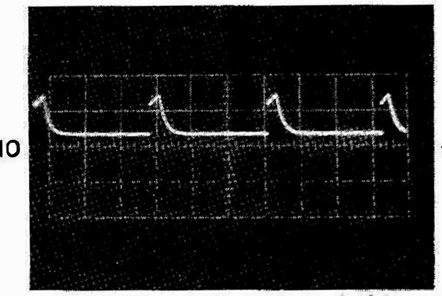
Figure SPA-27. Simplified Schematic of Vertical Blanking Generator Circuits



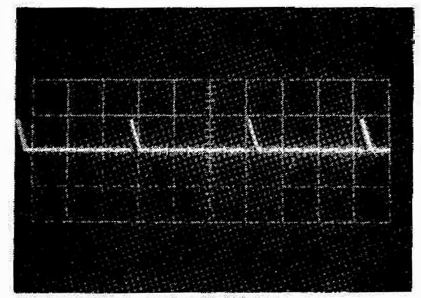
A. Emerg. Trigger 9J9-18 at 5000 micro-seconds/cm; 5v/division.



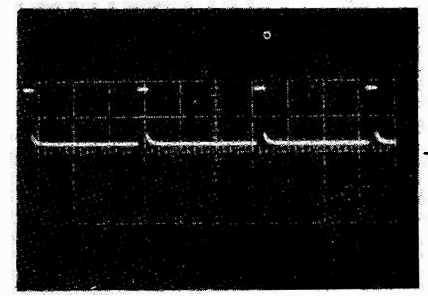
B. Anode of 9CR2 at 5000 micro-seconds/cm; 5v/division.



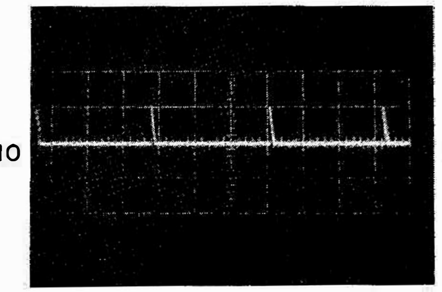
C. Cathode of 9CR2 at 5000 micro-seconds/cm; 5v/division.



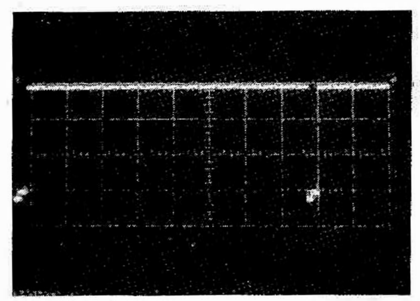
D. Base of 9Q1 at 5000 micro-seconds/cm; 5v/division.



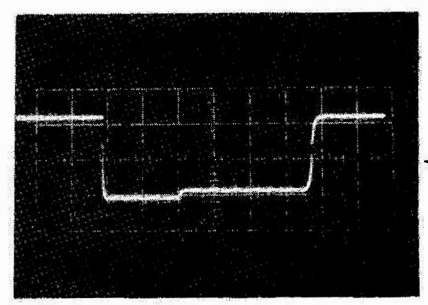
E. Collector of 9Q2 at 5000 micro-seconds/cm; 5v/division.



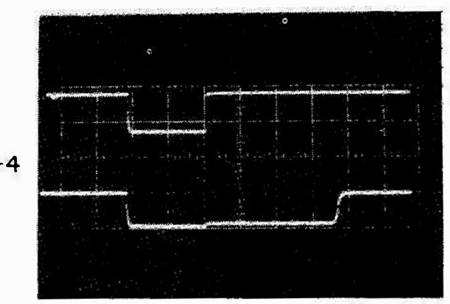
F. Base of 9Q3 at 5000 micro-seconds/cm; 5v/division.



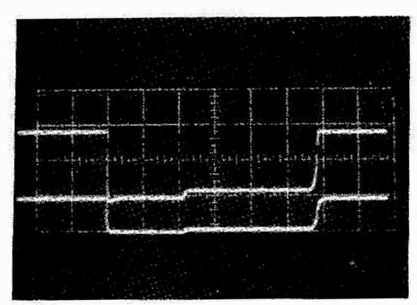
G. Collector of 9Q3 at 2000 micro-seconds/cm; 2v/division.



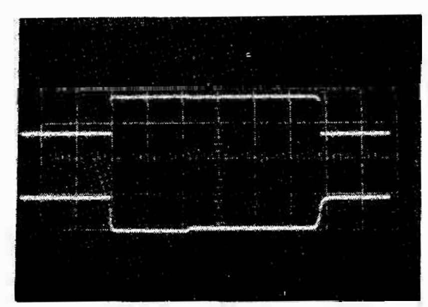
H. Test Point 9H, 9TP1 at 100 micro-seconds/cm; 2v/division.



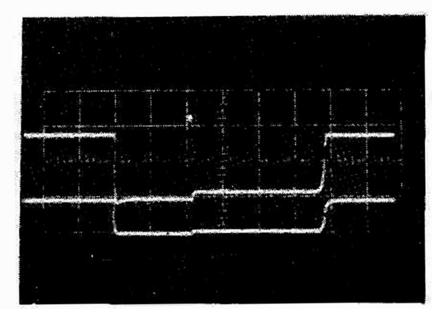
I. Top: 3.5H IN 9J9-1 at 100 micro-seconds/cm; 5v/division.
Bottom: 9H.



J. Top: Base of 9Q4 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



K. Top: Collector of 9Q4 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



L. Top: Emitter of 9Q4 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.

which is coupled to the base of 9Q1 through 9CR1 from the collector of the 9H amplifier 9Q4. The emergency trigger pulse is a positive going signal taken from the ÷3 multivibrator in the Vertical Advance Module and appearing simultaneously with the negative going edge (trailing edge) of the 3.5H pulse at the base of 9Q1. During normal conditions of operation, this pulse has no effect on the vertical blanking multivibrator which has already been triggered by the leading edge of the 3.5H pulse and which remains in that state for 21H. However, under unusual operating conditions due to a non-synchronous switch or a bad splice in the tape, the vertical sync period of the separated sync signal may arrive at a much later time. As explained in the description of the Vertical Advance Module, the leading edge of the 3.5H pulse is generated exactly 259H after the previous pulse even though the vertical sync has been delayed. The trailing edge of the 3.5H pulse is coincident with the second vertical sync pulse but since the second vertical sync pulse is delayed, the trailing edge of 3.5H will be delayed. Therefore, the 3.5H pulse will be much longer than 3.5H. This lengthened 3.5H pulse holds the vertical interval gate open, allowing separated sync to pass. When the vertical sync does arrive, a start pulse is generated at the leading edge of the second vertical sync pulse, resulting in the termination of the lengthened 3.5H pulse. This trailing edge of the lengthened pulse is negative going and does not trigger the vertical blanking multivibrator which has returned to its stable state 21H after the leading edge of the 3.5H pulse.

If there were no emergency trigger, the vertical interval gate would close, cutting off the remainder of the vertical interval. However, the positive going emergency trigger coincident with the trailing edge of

the lengthened 3.5H pulse, does trigger the vertical blanking multivibrator which in turn triggers the 9H generator. The 9H pulse holds the vertical interval gate open for the remainder of the vertical interval, minimizing the "roll" in the picture.

Sync Reassembly

In the reassembly of sync, as shown in the figure SPA-28, the 9H pulse from the vertical generator and the 3.5H pulse from the Vertical Advance Module are applied to the base of the vertical interval gate 9Q5 and the horizontal sync gate 9Q6. Normally, transistor 9Q5 is biased to saturation, shorting out the separated sync pulses which appear at its collector while transistor 9Q6 is biased to cut off so that the regenerated horizontal sync pulses appearing at its collector are applied to the base of the gated horizontal amplifier 9Q7 and to the base of the regenerated sync amplifier 9Q8 through the isolation diode 9CR8.

During the vertical interval, the 9H pulse applied to the base of 9Q5 drives it to cutoff, which permits the separated sync pulses to pass through the isolation diode 9CR7 to the base of 9Q8. Applied to the base of 9Q6, the 9H pulse drives 9Q6 to saturation and shorts out the regenerated horizontal sync pulses. The gated horizontal sync pulses are amplified by 9Q7 and the gated horizontal output is taken from its collector. During the vertical sync interval the pulses at the base of 9Q8 are separated sync and during the rest of the period, regenerated horizontal sync pulses. These pulses are amplified by transistor 9Q8 to provide regenerated sync for the Output Module and for the integrator driver 9Q9. The diode 9CR9 together with 9R20, 9R21 and 9C7 prevents the transistor 9Q8 from being driven into saturation. Diode 9CR10 provides a bias which insures that 9Q8 will be cut off in the absence of a pulse input.

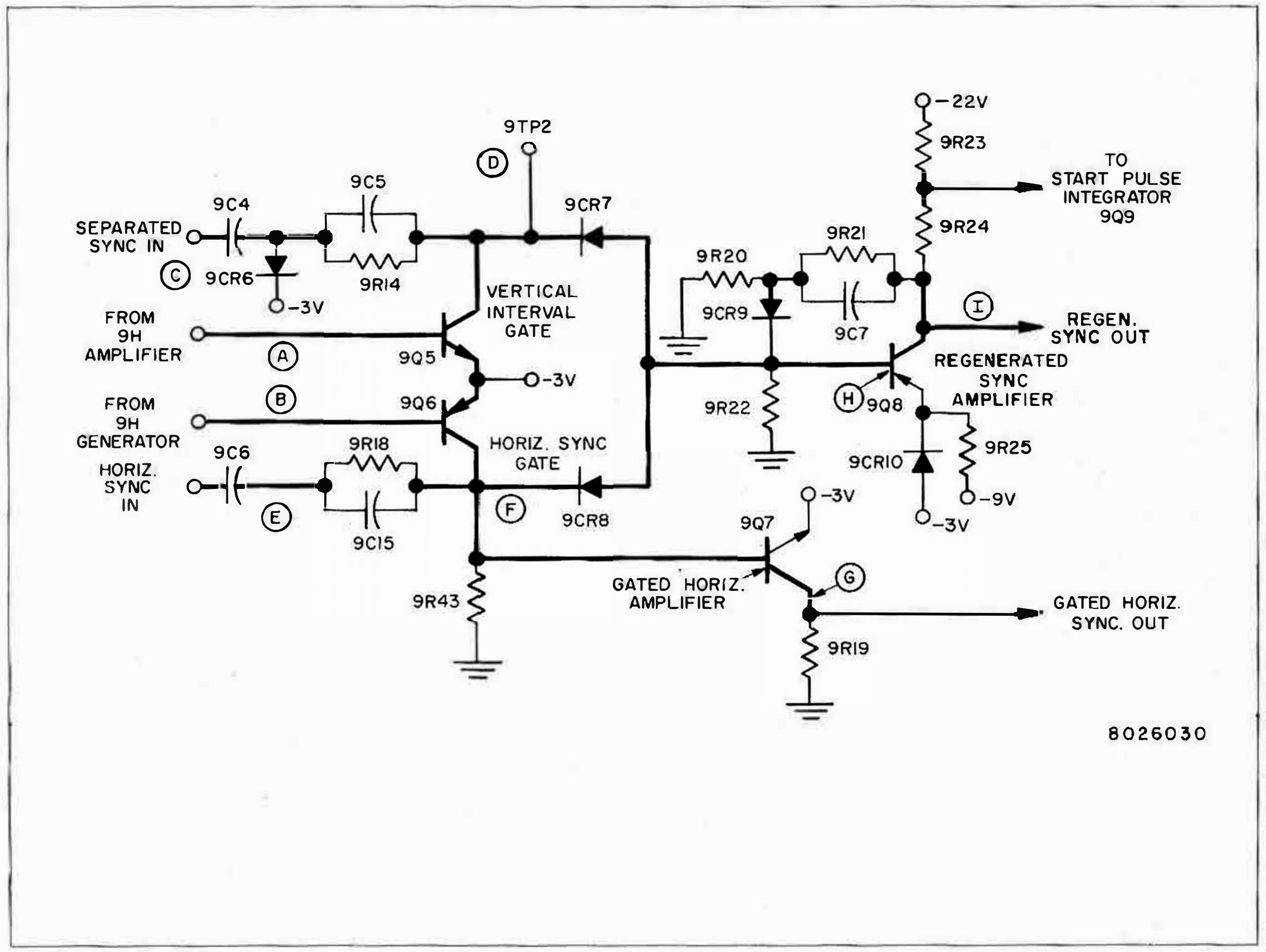
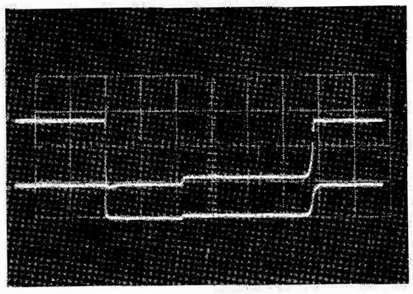


Figure SPA-28. Simplified Schematic of Sync Reassembly Circuits



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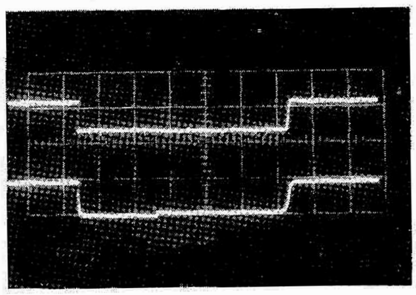
A. Top: Base of 9Q5 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



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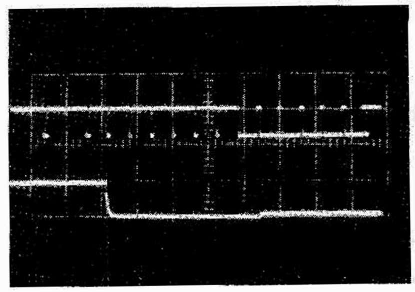
B. Top: Base of 9Q6 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



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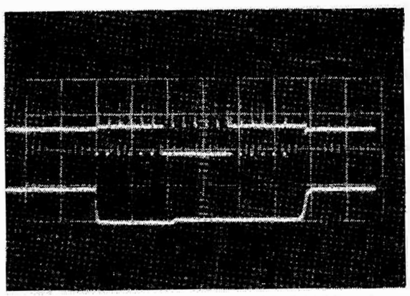
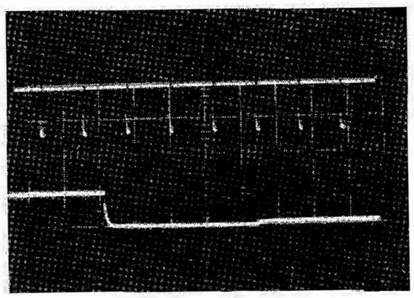
C. Top: SEP SYNC IN, 9J9-3 at 50 microseconds/cm; 5v/division.
Bottom: 9H.



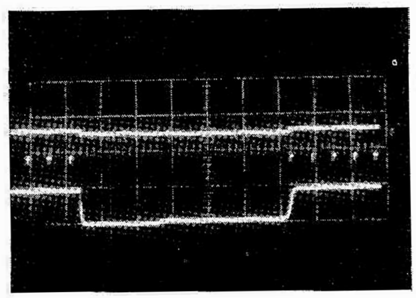
0

D. Top: Collector of 9Q5 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



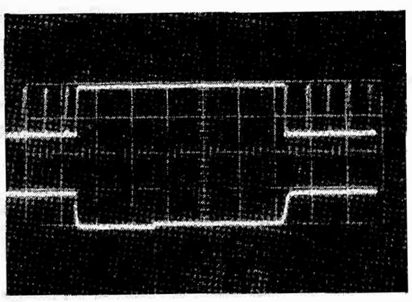
0

E. Top: HORIZ. SYNC IN 9J9-7 at 50 microseconds/cm; 5v/division.
Bottom: 9H.



0

F. Top: Collector of 9Q6 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



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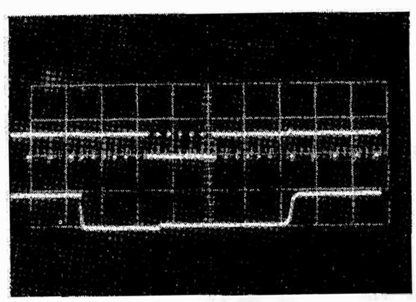
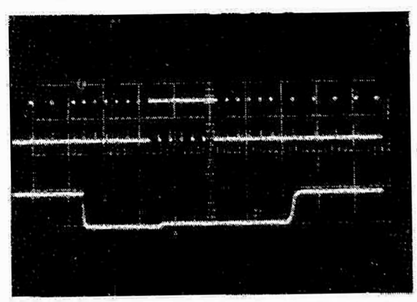
G. Top: Collector of 9Q7 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



-4

H. Top: Base of 9Q8 at 100 micro-seconds/cm; 2v/division.
Bottom: 9H.



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I. Top: Collector of 9Q8 at 100 micro-seconds/cm; 10v/division.
Bottom: 9H.

Start Pulse

The regenerated sync fed to the base of the integrator driver 9Q9 is amplified and passed through the integrating network 9R30 and 9C10. The time constant of this network is such that the output is mainly from the wide vertical sync pulses. The residual spikes from the horizontal and equalizing pulses are removed by diodes 9CR11 and 9CR12. As shown in figure SPA-29, the start pulse clipper 9Q10 amplifies the vertical pulse and clips it at a low level. A differentiating network consisting of capacitor 9C16 and the load in the Vertical Advance Module (8C19 and 8R39) provides a start pulse of short duration which begins to rise after the leading edge of the first sync pulse and returns to zero before the leading edge of the third vertical sync pulse. This pulse selects the one 31.5 kc pulse coincident with the leading edge of the second vertical sync pulse to trigger the counters.

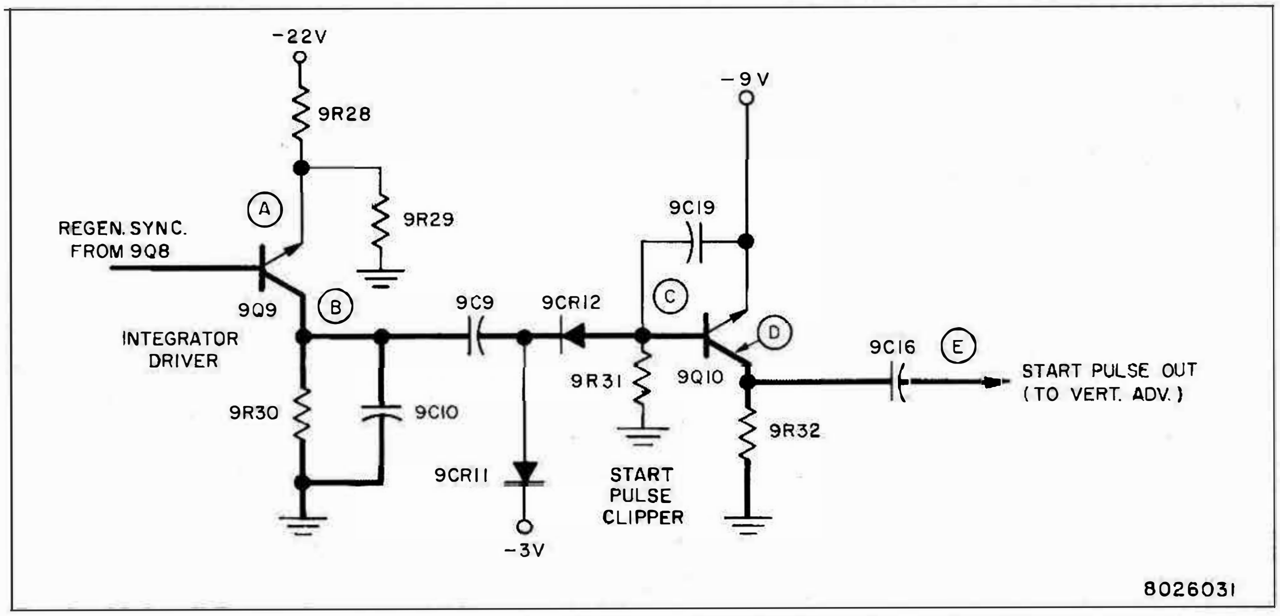
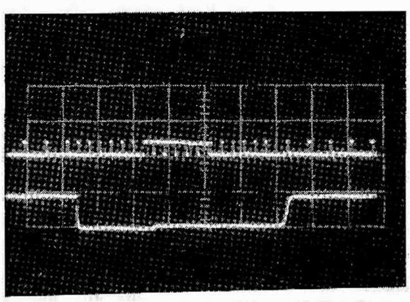
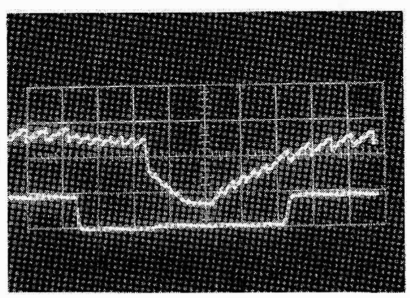


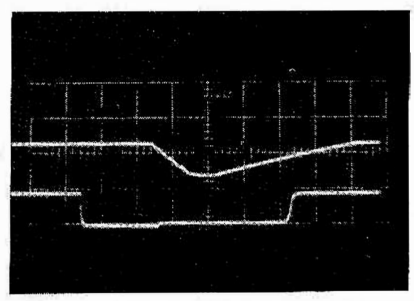
Figure SPA-29. Simplified Schematic of Start Pulse Circuits



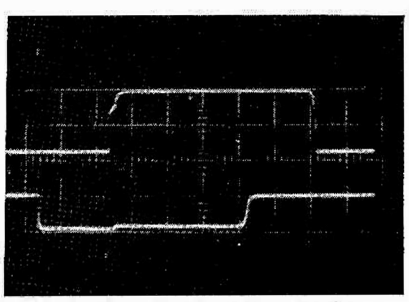
A. Top: Emitter of 9Q9 at 100 microseconds/cm; 10v/division.
Bottom: 9H.



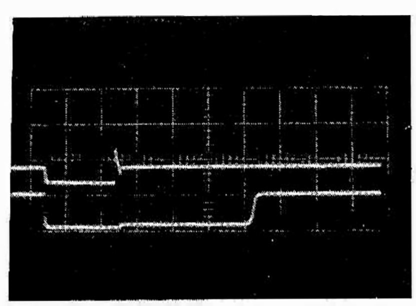
B. Top: Collector of 9Q9 at 100 microseconds/cm; 5v/division.
Bottom: 9H.



C. Top: Base of 9Q10 at 100 microseconds/cm; 5v/division.
Bottom: 9H.



D. Top: Collector of 9Q10 at 100 microseconds/cm; 5v/division.
Bottom: 9H.



E. Top: Start Pulse Out 9J9-9 at 100 microseconds/cm; 5v/division.
Bottom: 9H.

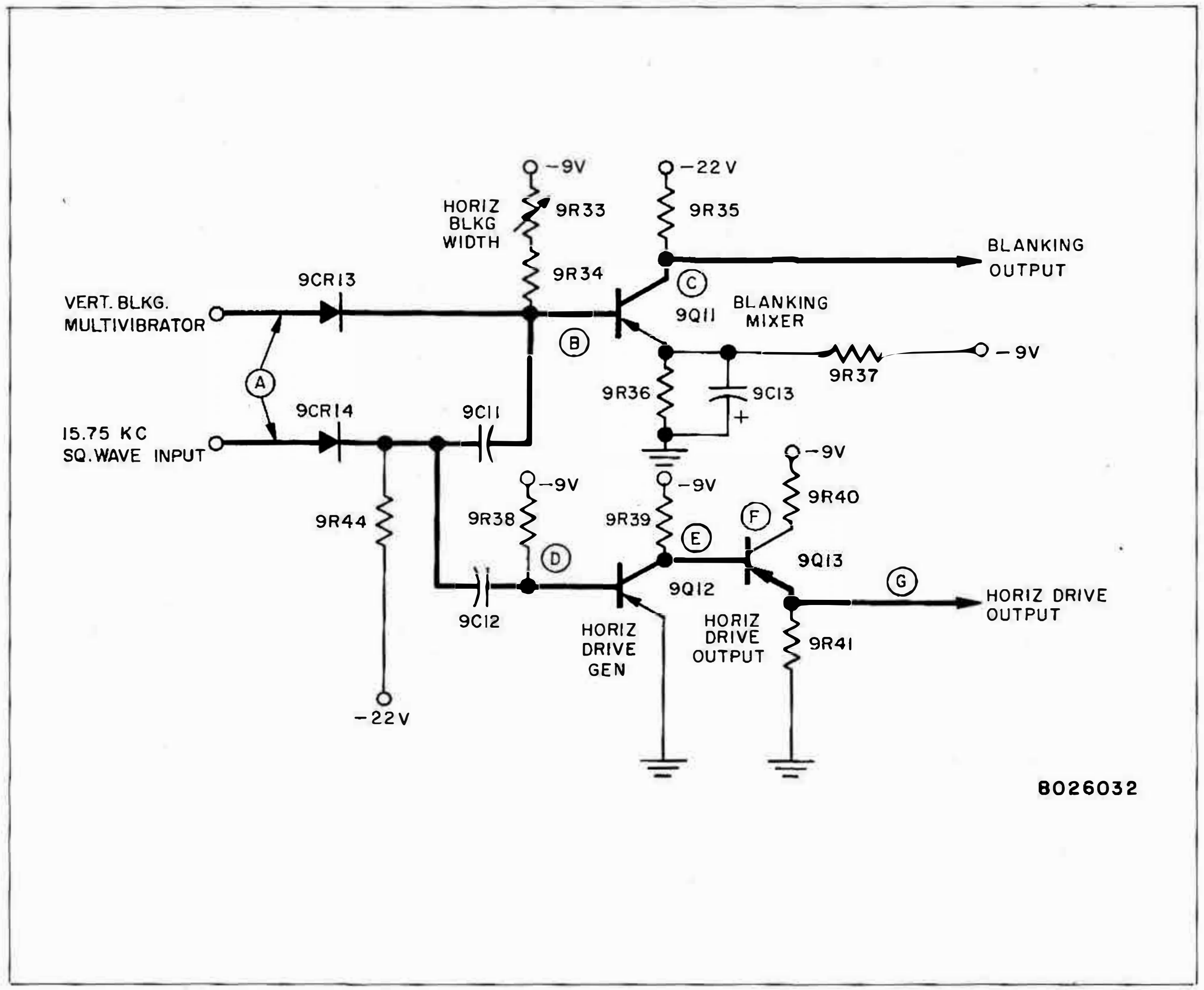
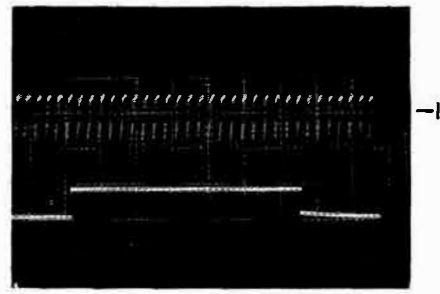


Figure SPA-30. Simplified Schematic Blanking and Horizontal Drive Circuits

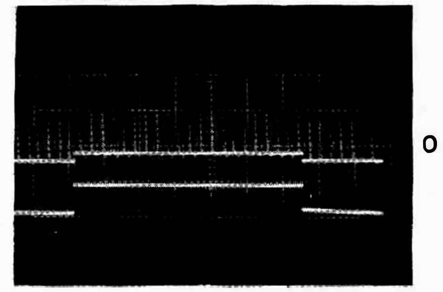
Two additional outputs are provided by this module, the blanking output and the horizontal drive output. As shown in the simplified schematic figure SPA-30, the 15.75 kc square wave input from the Horizontal AFC Module is coupled through the isolation diode 9CR14 to the blanking mixer 9Q11 and the horizontal drive generator 9Q12. Both of these circuits are the pulse narrowing* type. The time constant 9C12 and 9R38 has been set to generate a horizontal drive pulse of six microseconds duration. The drive pulse is direct-coupled from the collector of 9Q12 to the base of the horizontal drive output transistor 9Q13. The amplitude of this output pulse at the emitter of 9Q13 is —4 volts.

The time constant of 9C11, 9R33 and 9R34 in the base circuit of the blanking mixer transistor 9Q11 is adjustable and is set to provide horizontal blanking pulses of approximately nine microsecond-duration by the H. BLKG WIDTH control. The vertical blanking pulse from the multivibrator, 9Q1, 9Q2, is coupled directly to the base of 9Q11 through the isolation diode 9CR13. During the 21H vertical blanking period, 9Q11 is cut off, thereby generating the vertical blanking pulse and preventing the generation of horizontal blanking pulses. The output from the collector of 9Q11 is a composite horizontal and vertical blanking signal.

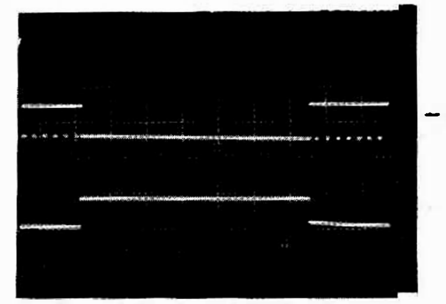
* See Basic Circuit Descriptions on p. SPA-48.



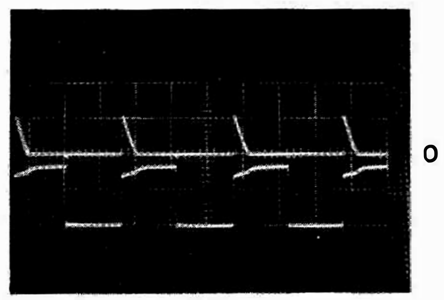
A. Top: 15.75 KC IN 9J9-5 at 200 microseconds/cm; 1v/division. Bottom: 21H (9Q2-C).



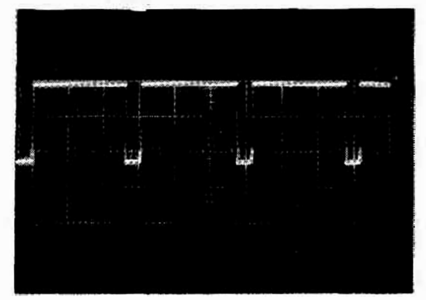
B. Top: Base of 9Q11 at 200 microseconds/cm; 5v/division. Bottom: 21H (9Q2-C).



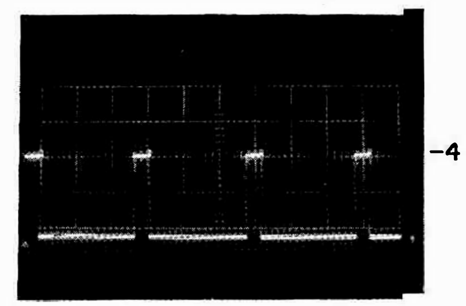
C. Top: Collector of 9Q11 at 200 microseconds; 5v/division. Bottom: 21H (9Q2-C).



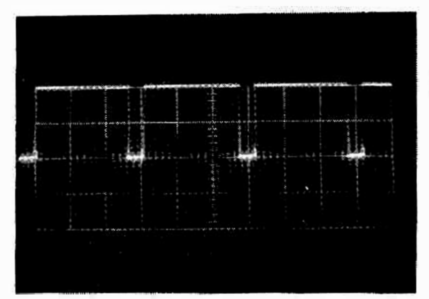
D. Top: Base of 9Q12 at 20 microseconds/cm; 5v/division. Bottom: 15.75 KC IN.



E. Collector of 9Q12 at 20 microseconds/cm; 2v/division.



F. Collector of 9Q13 at 20 microseconds/cm; 2v/division.



G. Emitter of 9Q13 at 20 microseconds/cm; 2v/division.

SYNC LOGIC MODULE

5. Color Module

(Refer to Block Diagram Figure SPA-31.)

As explained in the paragraphs *Overall* and *Input and Blanking Module* under *Circuit Description,* the COLOR/MONO relay K1 is normally energized when the processing amplifier is operating in a color system. Refer to the diagram showing the signal path for a color system, figure SPA-8.

While the luminance signal from the low pass filter returns to the Input and Blanking Module, the high-pass filter effectively separates out the chroma portion of the signal, which then passes through the amplifiers 5Q1, 5Q2 and 5Q3 in cascade as shown in figure SPA-32. The collector of circuits 5Q2 and 5Q3 are clamped to ground through the bridge connected diodes 5Z1 and 5Z2 during the blanking interval, thereby removing burst and other disturbances. The diodes 5Z1 and 5Z2 are driven by clamp drivers, 5Q4 and 5Q5, which amplify the input blanking signal. New burst is then added to the chroma signal and the combined signals are fed to the Output Module.

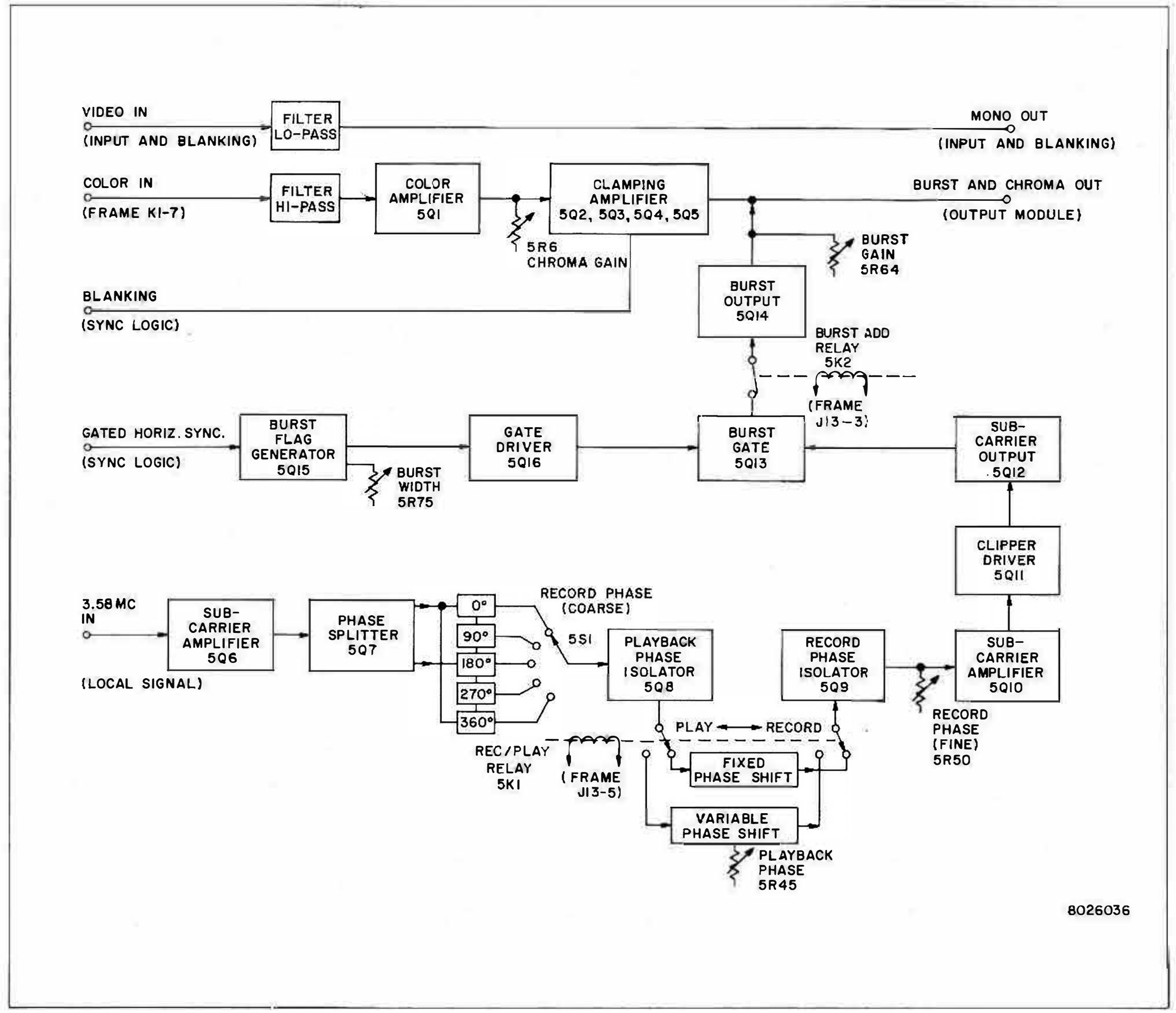


Figure SPA-31. Block Diagram of Color Module

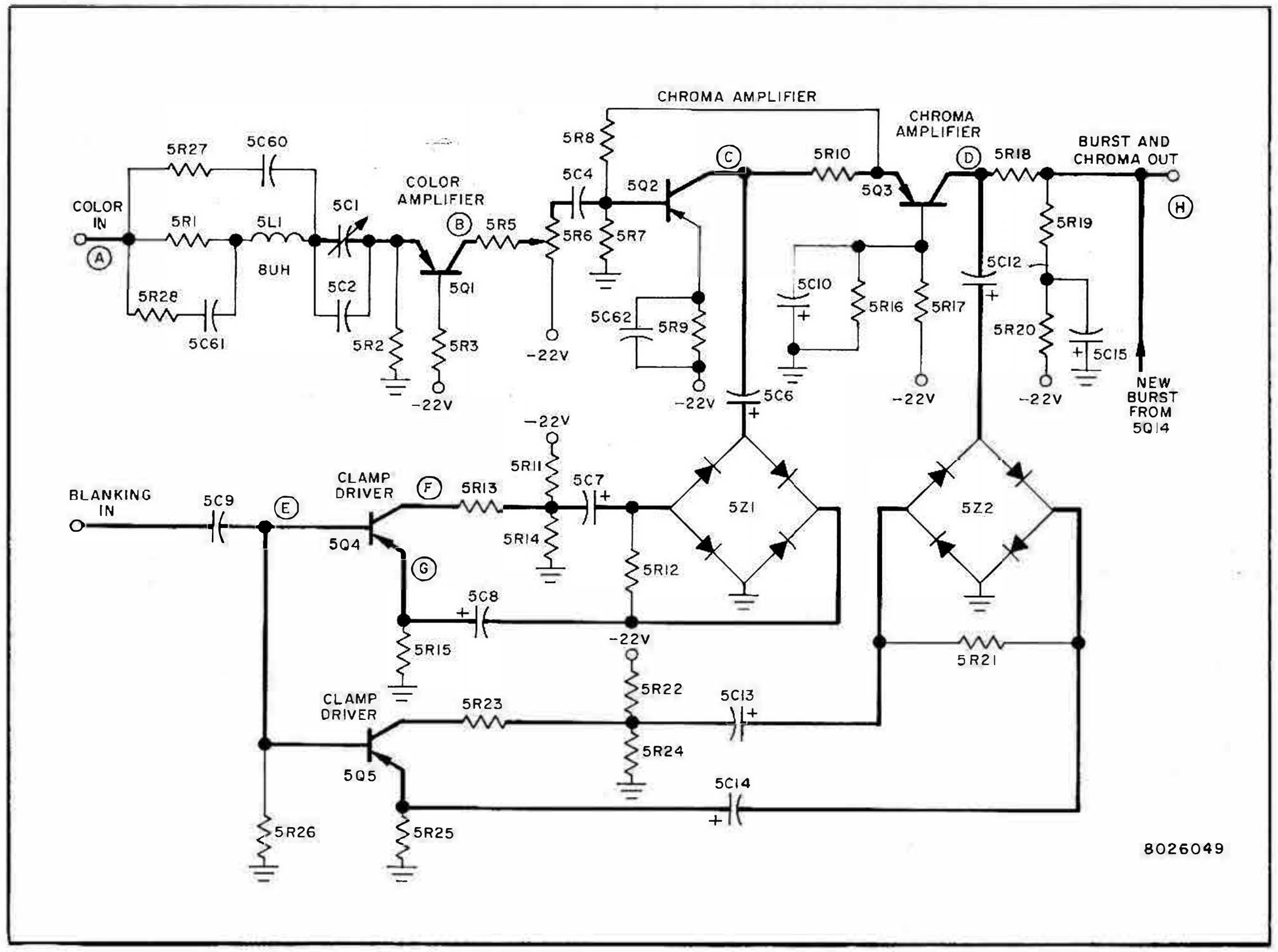
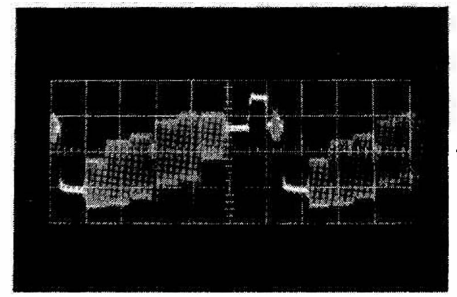
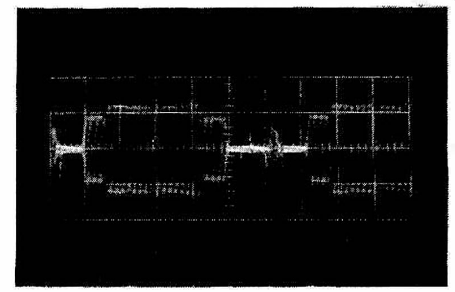


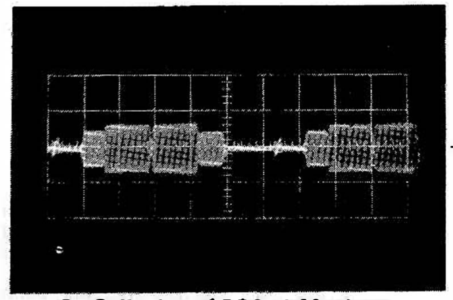
Figure SPA-32. Simplified Schematic of Removal of Old Burst and Addition of New Burst


−18

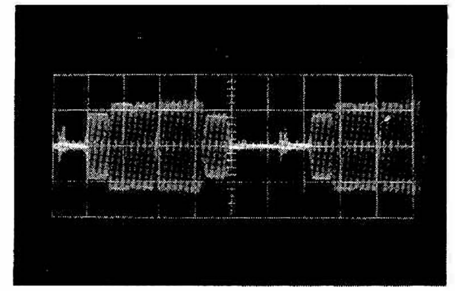
A. Color In 5J5-2 at 10 microseconds/cm; .2v/division.


−18

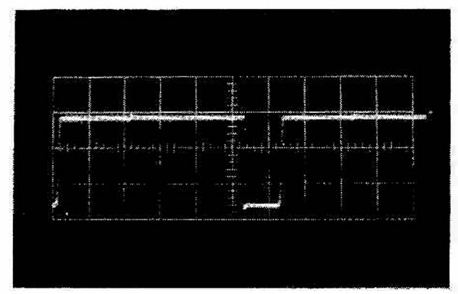
B. Collector of 5Q1 at 10 microseconds/cm; .2v/division.


−7

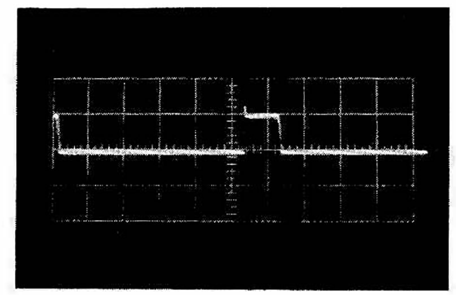
C. Collector of 5Q2 at 10 microseconds/cm; 2v/division.


0

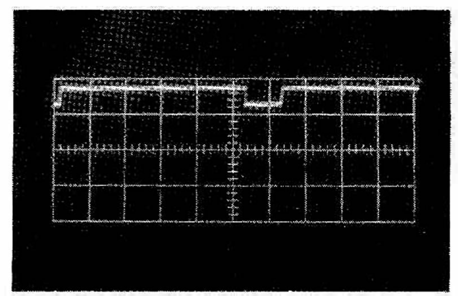
D. Collector of 5Q3 at 10 microseconds/cm; 1v/division.


0

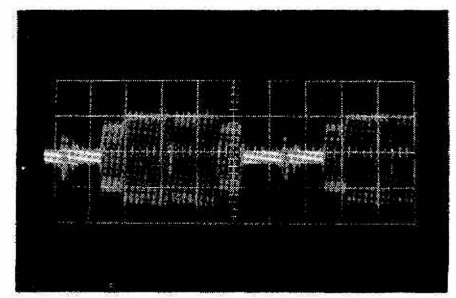
E. Base of 5Q4 and 5Q5 at 10 microseconds/cm; 2v/division.


−10

F. Collector of 5Q4 at 10 microseconds/cm; 5v/division.


0

G. Emitter of 5Q4 at 10 microseconds/cm; 5v/division.


−20

H. Burst and Chroma Out 5J5-13 at 10 microseconds/cm; .05v/division.

Phase Shift Networks

Two subcarrier phase shift circuits are provided, one for the RECORD mode of operation, one for PLAYBACK. Refer to figure SPA-33. Two phase shifts are necessary to compensate for differences in system delays between the two modes. The relay 5K1 automatically selects the required phase-shift circuitry. The subcarrier signal is amplified by the RC-coupled amplifiers 5Q6, 5Q7 and fed through the transformer 5T1 to the phase-shifting network. To permit a coarse adjustment of the subcarrier phase, taps on the network and the transformer are connected to a five-position switch, RECORD PHASE, 5S1. This switch is adjusted during recording operation but the phase shift selected remains in the circuit during both playback and recording. The signal is then fed through an emitter follower, isolation stage 5Q8 (playback phase isolator) to a set of contacts of the burst phase relay 5K1. When this relay is energized (RECORD and SETUP system operation only) a fixed phase-shift network is inserted between the playback phase isolator 5Q8 and the record phase isolator 5Q9. When the relay is deenergized, a variable phase network which is controlled by the PLAYBACK PHASE potentiometer 5R45, is inserted in the circuit. The output of 5Q9 is then fed through the fine control RECORD PHASE 5R50 and an amplifier, 5Q10, to a clipper circuit. This clipper circuit, which consists of transistor 5Q11 and three diodes 5CR1, 5CR2, 5CR3, drives the subcarrier output stage. To form the burst signal, burst gate 5Q13 shorts the signal except when a pulse from the burstflag channel is present.

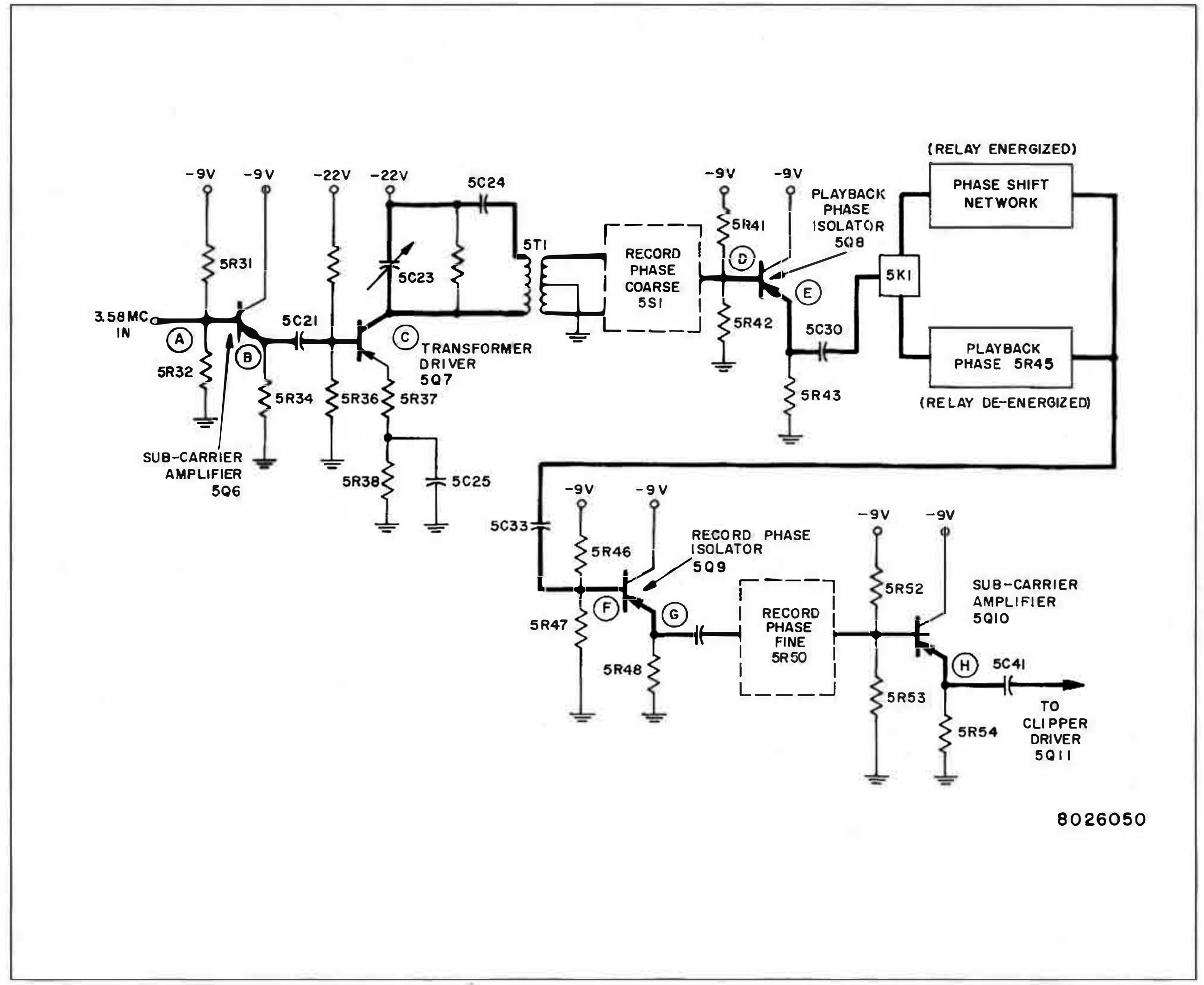
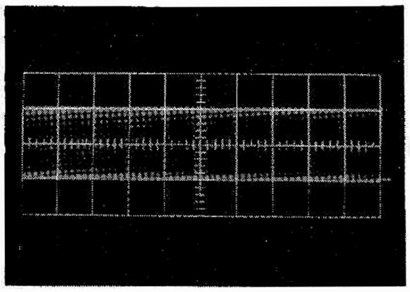
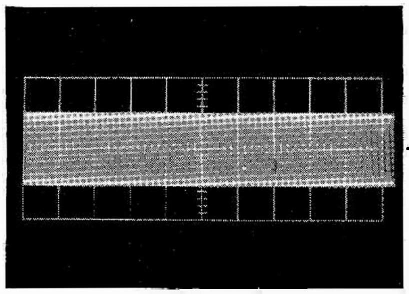


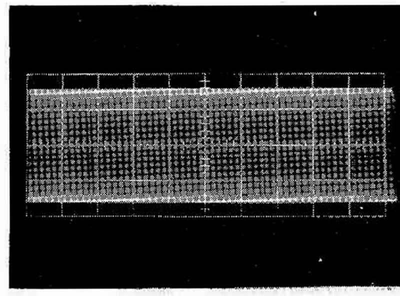
Figure SPA-33. Simplified Schematic of Record and Playback Phase Control Circuits


0

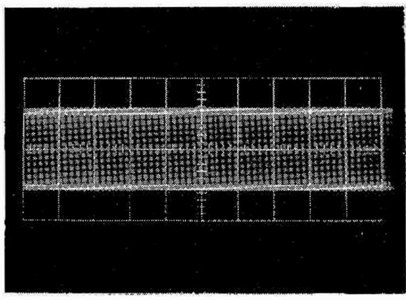
A. 3.58 IN 5J5-24 at 10 micro-seconds/cm; 1v/division.


-4

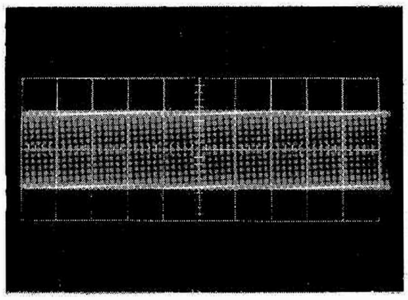
B. Emitter at 5Q6 at 10 micro-seconds/cm; 1v/division.


-10

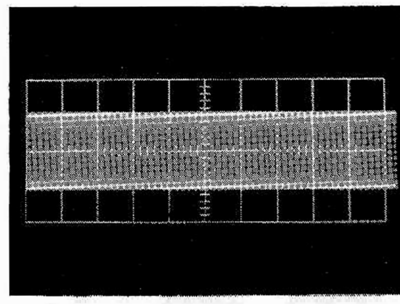
C. Collector of 5Q7 at 10 micro-seconds/cm; 2v/division.


-4

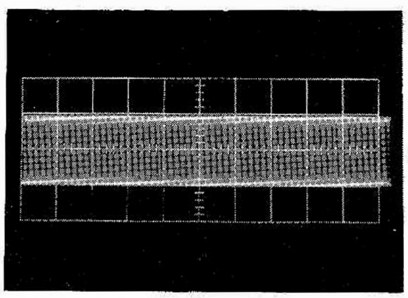
D. Base of 5Q8 at 10 micro-seconds/cm; .5v/division.


-4

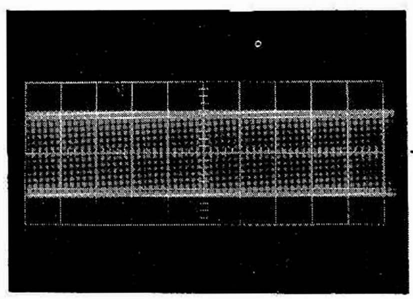
E. Emitter of 5Q8 at 10 micro-seconds/cm; .5v/division.


-4

F. Base of 5Q9 at 10 micro-seconds/cm; .5v/division.


-3

G. Emitter of 5Q9 at 10 micro-seconds/cm; .5v/division.


-3

H. Emitter of 5Q10 at 10 micro-seconds/cm; .5v/division.

Burst Flag

As shown in figure SPA-35, the input to the burst flag channel is gated horizontal sync from the Sync Logic Module. This signal is fed to a burst flag generator which produces negative pulses timed to occur only during the desired burst interval. This pulse, whose width is determined by 5R75, the BURST WIDTH potentiometer, is fed through the driver stage 5Q16 to the burst gate 5Q13. In the intervals between the pulses the gate conducts and effectively shorts the subcarrier. However, when the pulse is present, the gate is cut off until the desired number of cycles, determined by 5R75, enter the burst output stage. The burst output, whose amplitude is controlled by BURST GAIN control 5R64, is fed to the output jack of the Color Module where it is added to the chroma signal. The color signal then goes to the Output Module to be added to the luminance signal as explained in the description of the Output Module.

Relays

For the function of the three relays, K1 on the frame and 5K1 and 5K2 on the Color Module, refer to the simplified relay schematic figure SPA-34. All three of these relays are controlled by 24 volts d.c. supplied from the system. Relay 5K1 (RECORD/PLAY) is energized when the recorder is in RECORD, SETUP, or STANDBY operation. Relay K1 (COLOR/MONO relay) which is located on the frame of the processing amplifier is energized when DEMOD switch S2 is in the COLOR position, BURST OSC switch S1 is in the OPERATE position and the Tape Recorder is in RECORD, PLAY, SETUP or STANDBY mode. Relay 5K2 (BURST ADD relay) is energized when all the conditions for energizing K1 are met and in addition, the CHROMA PROCESSOR relay K2 is energized by the presence of burst on the signal.

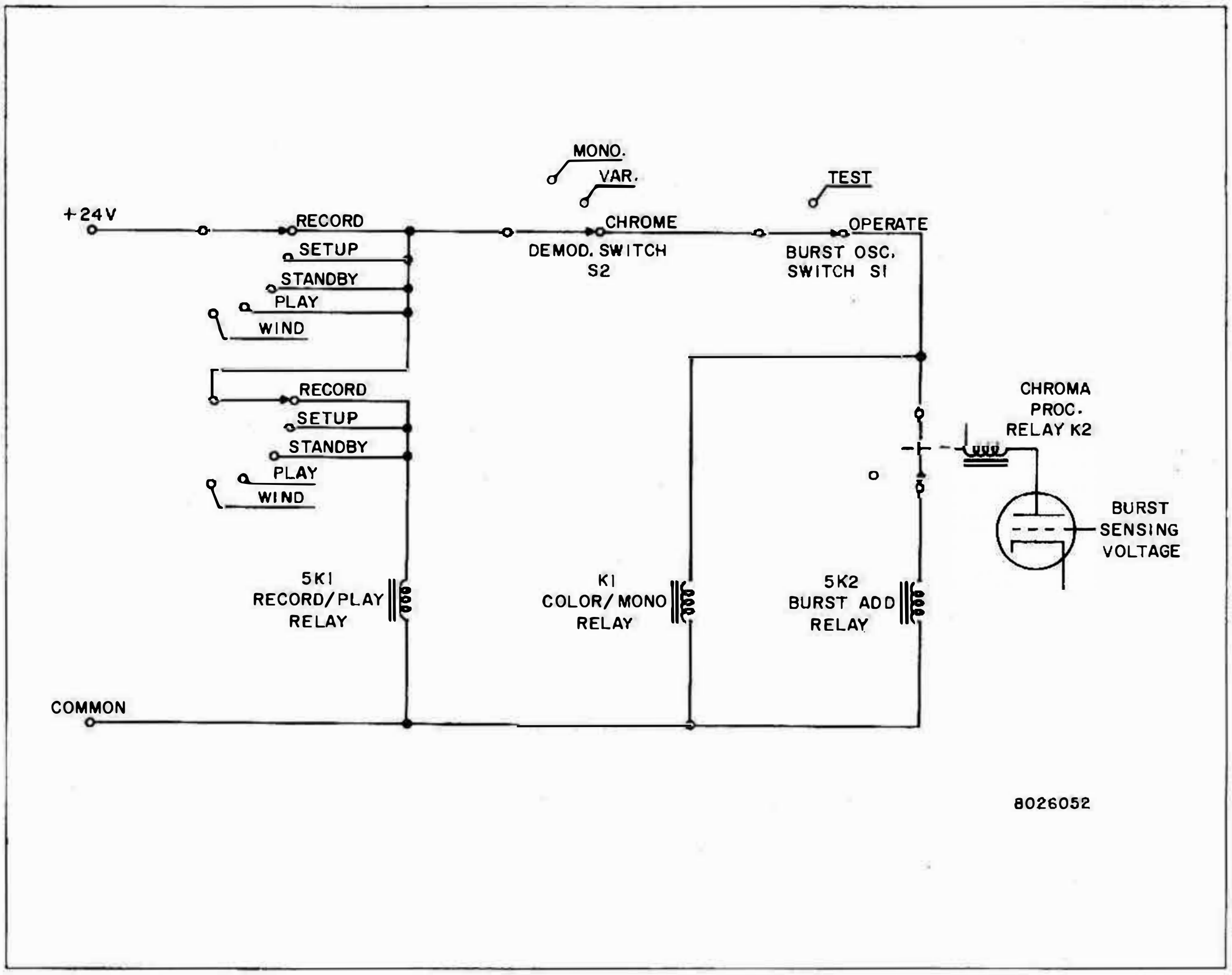


Figure SPA-34. Simplified Relay Schematic

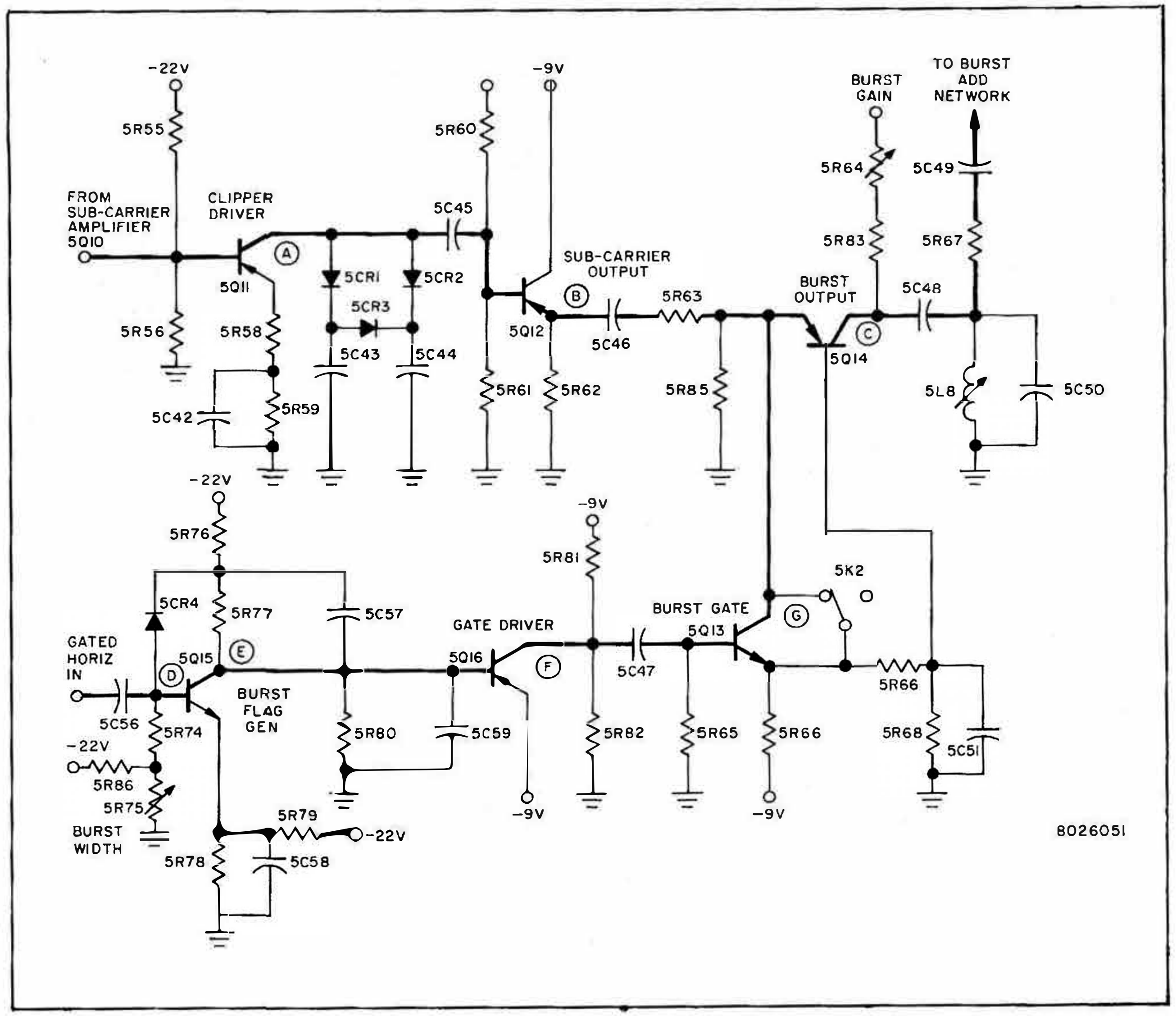
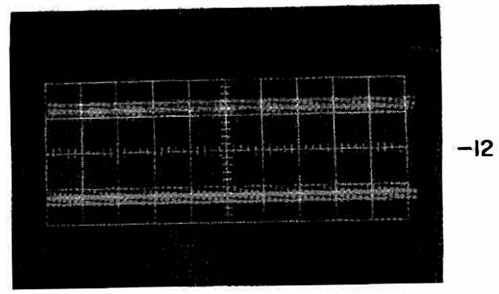
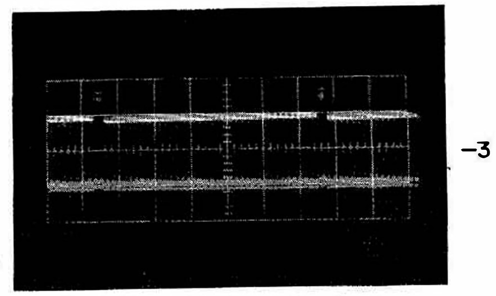


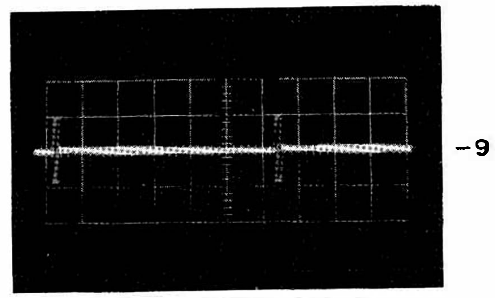
Figure SPA-35. Simplified Schematic of Burst Shaping and Gating Circuits



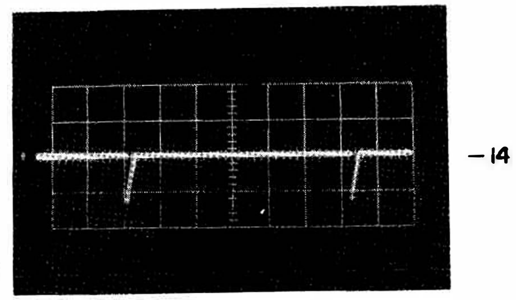
A. Collector of 5Q11 at 10 micro-seconds/cm; .5v/division.



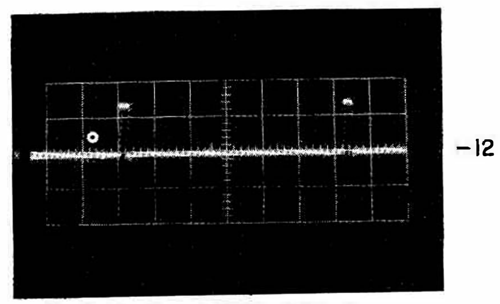
B. Emitter of 5Q12 at 10 micro-seconds/cm; .5v/division.



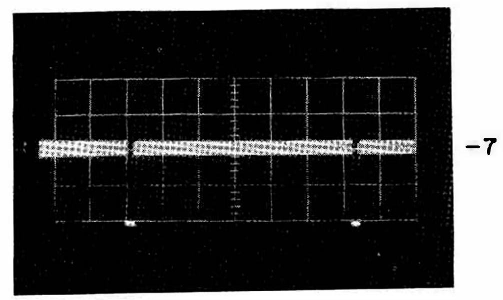
C. Collector of 5Q14 at 10 micro-seconds/cm; .5v/division.



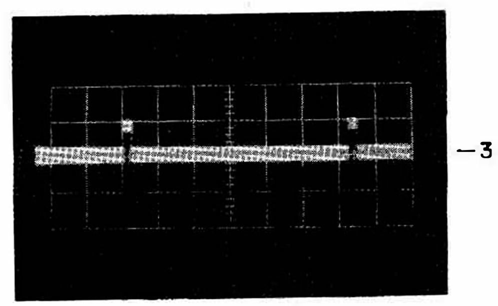
D. Base of 5Q15 at 10 micro-seconds/cm; 2v/division.



E. Collector of 5Q15 at 10 micro-seconds/cm; 2v/division.



F. Collector of 5Q16 at 10 micro-seconds/cm; 1v/division.



G. Collector of 5Q13 at 10 micro-seconds/cm; 1v/division.

Power 1 and Power 2 Modules

(Refer to Block Diagram Figure SPA-36.)

Two modules contain the power supply components, and provide regulated d-c outputs at −9 volts and −22 volts and an unregulated d-c output at −17 volts. Power 1 Module contains the power transformer, voltage doubler, filter and regulator circuits. Power 2 Module contains the two series regulators which are used in the −9 volt and −22 volt regulating circuits. The d-c outputs at −9 volts, −17 volts (unregulated) and −22 volts appear on terminals 11J11-2, 11J11-16 and 11J11-11 respectively on Power 1 Module.

On Power 1 Module, 117 volts 60 cycles AC is connected through terminals 15 and 19 through the fuse 11F1 to the primary of the stepdown transformer 11T1. Voltage from the secondary winding of 11T1 is applied to the voltage doubler which supplies d.c. to the two regulator circuits through the fuses 11F2 (−22 volt source) and 11F3 (−9 volt and −17 volt source) as shown in the block diagram.

From the fuse 11F2, d.c. passes through the series regulator 12Q2 to the −22 volt output terminal 11J11-11. From the fuse 11F3, d.c. is fed through the series regulator 12Q1 to the −9 volt output terminal 11J11-2. The output voltage is read directly on the scale of the voltmeter 11M1 which is normally connected across the −22 volt output through the switch 11S1. When the READ −9 volt switch is depressed, the meter is then connected across the −9 volt output. The −9 volt and −22 volt outputs of the power supply are controlled by the setting of the −22V ADJ control 11R12.

Regulator Circuit

For a clearer understanding of the function of the −22 volt series regulator circuit, refer to the simplified diagram figure SPA-37 and read the following analysis carefully. The current source 11Q2 provides for a constant (total) current flow of approximately 3 ma. from two branches of the circuit (D and E) in the direction shown by the arrows. Thus, characteristically, an increase in current flow in one branch results in a proportionate decrease in current flow in the other branch and vice versa. The amount of current flowing in these two branches depends upon the relationship between the reference voltage provided by the Zener diode 11CR4 and the voltage at the arm of the −22V ADJ potentiometer 11R12.

With reference to the diagram figure SPA-37, the operation is as follows: Assume that the voltage appearing at point A increases as the result of either a decrease in the load R_L, or an increase in the unregulated voltage at G. Then since 11R12 is across the load, a voltage increase also occurs at point B. This increase

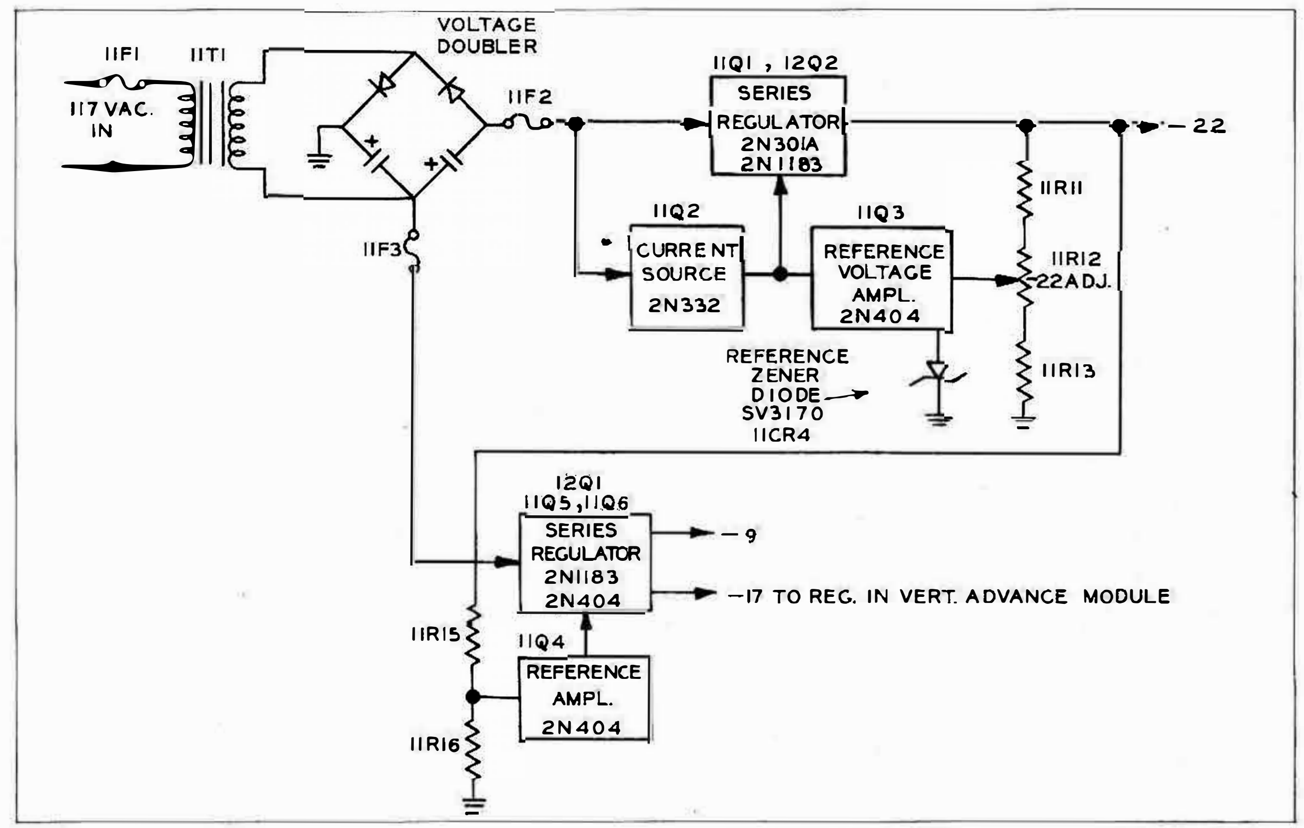


Figure SPA-36. Block Diagram of Power 1 and Power 2 Modules

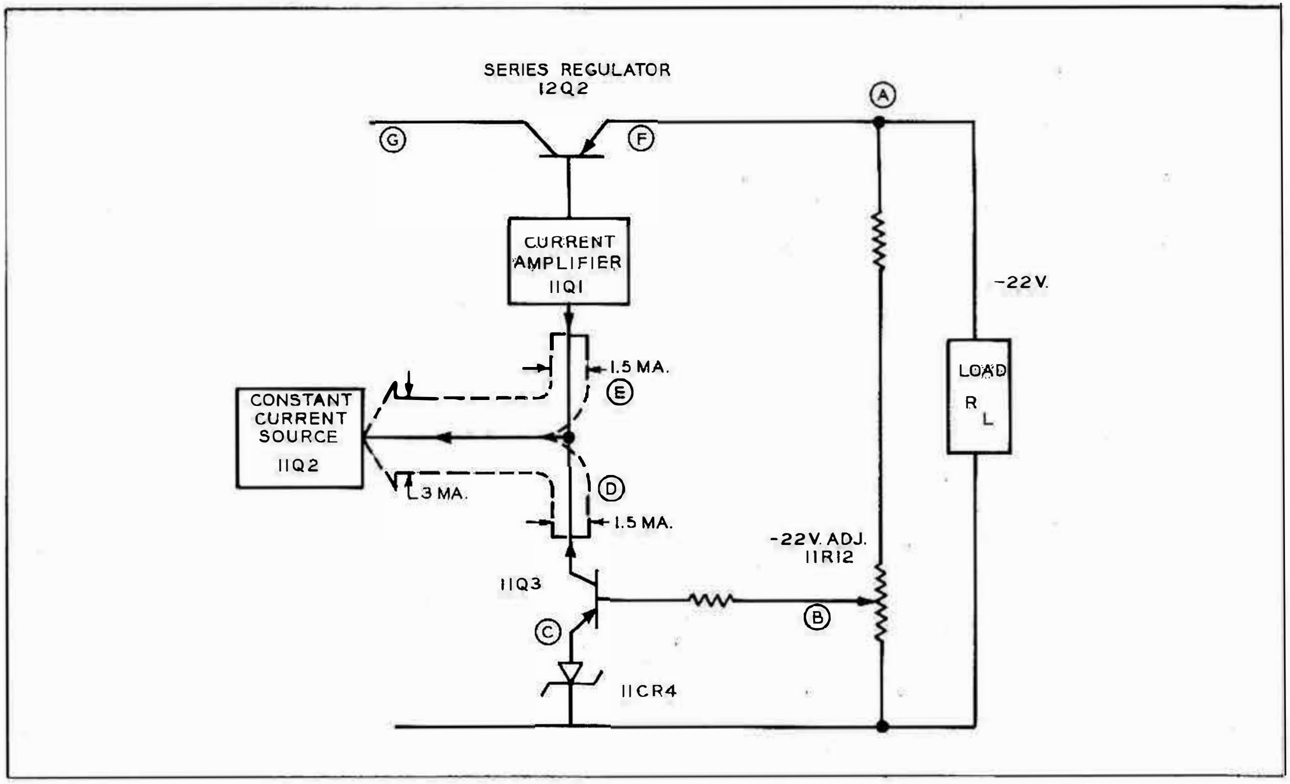


Figure SPA-37. Diagram Showing Regulator Current Flow

produces increases in current flow in both C and D and a decrease in current flow in E. The reduced current flow in E, in turn, results in a decrease in current flow in F, which reduces the output voltage at A as required. Conversely, if the voltage at A is reduced by a change in load or by variations in the unregulated supply voltage, the reference voltage at B decreases, lowering the current in C and D which produces an increase in the currents E and F, resulting in an increase in the voltage output A.

The operation of the −9 volt regulator circuit is similar. The resistor 11R16 in conjunction with the d-c amplifier 11Q4, develops the Zener-like reference voltage which is compared to the voltage appearing at the junction of series resistors 11R21 and 11R22 connected across the −9 volt output. The current source in the −9 volt regulator is provided by the resistor 11R18. Since 11R15 and 11R16 are fed by the regulated −22 volt supply, voltage output at the −9 volt terminal is directly proportional to that appearing at the −22 volt terminal. Thus when the −22V ADJ control is adjusted for −22 volts, the −9 volts output is automatically obtained at 11J11-2.

The unregulated −17 volt output is fed through terminal 11J11-16 to a separate regulator circuit 8Q14 in the Vertical Advance Module.

Basic Circuit Descriptions

The three basic types of transistor configurations, common emitter, common base and common collector (emitter follower) are used in all the modules. These circuits are in many cases analogues to vacuum tube circuitry. However, some circuits, depending on the fact that both PNP and NPN transistors are available, have no direct analogy to vacuum tube circuits. In an effort to clarify both these special circuits and to show the relationship between vacuum tube circuits and transistor circuits, several basic circuit descriptions are given in the following paragraphs:

1. Multivibrators

a. An *Astable* Multivibrator is a two-stage oscillator in which one stage conducts while the other is cut off until a point is reached at which the stages reverse their condition; that is, the stage which has been conducting cuts off, and the stage that has been cutoff, conducts. This type of oscillator is normally used to produce a square wave. The emitter-coupled transistor multivibrator is analogous to the cathode-coupled electron tube multivibrator circuit; or a collector-coupled transistor multivibrator is analogous to the plate coupled tube type. The time constants of the capacitors and resistors in the circuit determine the frequency. This type of multivibrator is used in the Horizontal AFC Module, 6Q1 and 6Q2.

b. A *Monostable* Multivibrator, basically, is a multivibrator having one stable and one unstable condition. A trigger drives the unit into the unstable state where it remains for a period of time determined by a time constant. The operating point then moves back to the original stable region. As in a vacuum tube circuit, one transistor may be conducting while the other is cutoff.

In the Signal Processing Amplifier, another combination has been used. Using an NPN and a PNP (complementary-symmetry), both transistors may be OFF in the relaxed or stable state or both may be ON. The trigger then drives both transistors to the ON state, or OFF state, whichever the case may be, and then they return to the relaxed or stable state at the end of the timing cycle. This is the type of multivibrator used for the counting multivibrators in the Vertical Advance and Horizontal AFC Modules.

2. Pulse Narrowing Circuits

(Refer to Figure SPA-38.)

At several points in the processing amplifier circuits, the generator used narrows the input pulse to obtain the desired output pulse. These circuits are used to produce horizontal sync, horizontal drive, horizontal blanking, burst flag and the 9H pulse. The transistor circuit used for this purpose is analogous to the more familiar vacuum tube circuit which is sometimes called a "boxcar".

In the vacuum tube version, the grid of the tube is connected through a resistance R1 to the plate supply and the cathode is grounded. With no signal at the grid coupling capacitor C, the grid-cathode diode draws current through R1, reducing the grid to approximately zero potential. The plate of the saturated tube draws current through R2, reducing the potential at the plate to some low voltage. Application of a negative pulse at C cuts the tube off and stops the flow of grid current through R1. The grid-resistor current then flows into the capacitor, recharging it to its original potential with no signal. Therefore, the waveform at the grid is an R/C exponential one, charging toward +100 volts. As soon as this charging exceeds zero volts, the grid becomes positive and again draws current, thereby stopping the waveform at zero. At the plate, a pulse of opposite polarity is produced that is narrower than the input pulse. The actual width of the pulse in the output circuit depends on the value of R and C in the input circuit.

As shown in the diagram, the action of the NPN transistor circuit is similar, except that the output pulse amplitude is equal to the power supply voltage, due to the excellent saturating characteristics of the transistor, and the trailing edge of the pulse is sharper. A transistor type PNP may be used as successfully as the NPN type shown, but with opposite input and output pulse polarities.

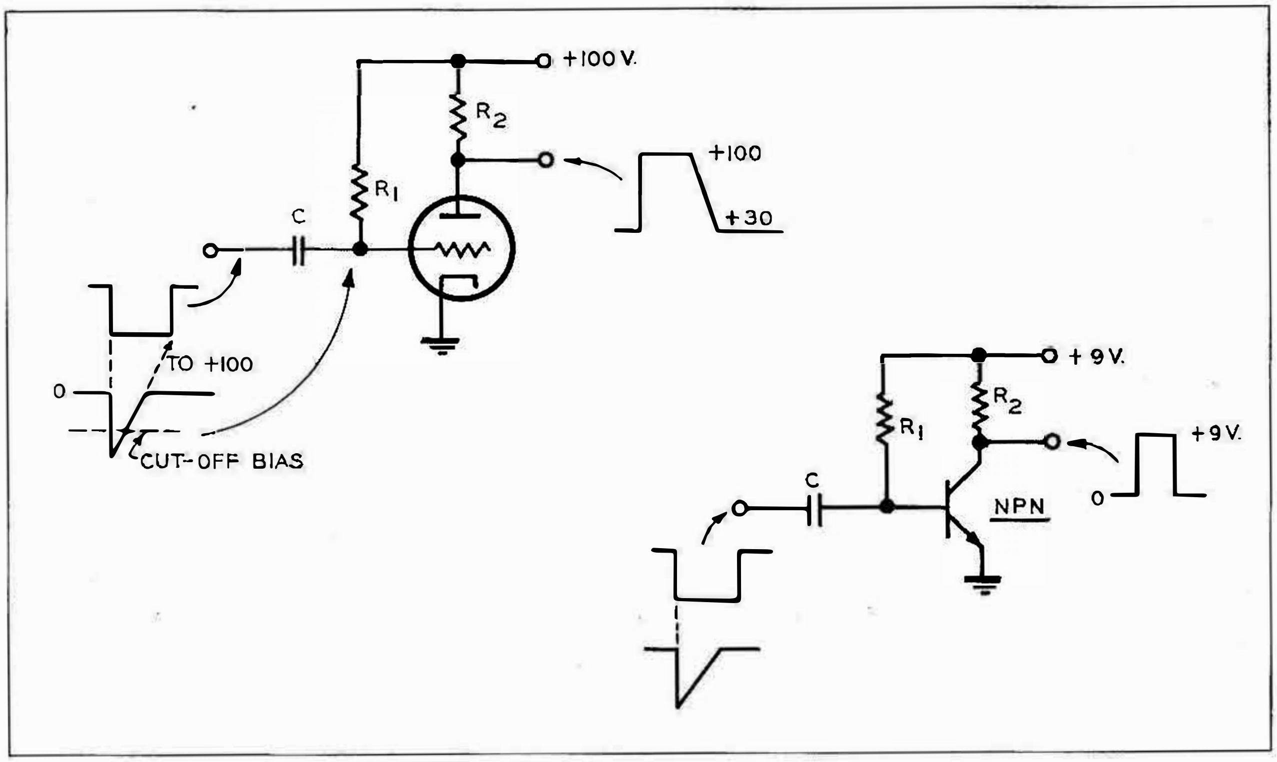


Figure SPA-38. Vacuum Tube and NPN Transistor Pulse Narrowing Circuits

SETUP FOR OPERATION

Initial Setting of Controls

A procedure for checking the entire system before operation is provided in the *System Operation Manual.* For the initial adjustments to be made on the processing amplifier proceed as follows:

For a *Monochrome* system, the adjustments are as follows:

1. Adjust the VID LEVEL control to obtain 0.7 volts blanking to peak white on the oscilloscope. (100 IRE units.)

2. Adjust the PEDESTAL control for 5% pedestal indication on the oscilloscope. (5 IRE units.)

3. Adjust the SYNC LEVEL control for 0.3 volts peak-to-peak sync. (40 IRE units.)

For *Color* system, add the following adjustments:

1. Adjust CHROMA gain for normal chroma level. (Compare color bar amplitude on input and output of the Tape Recorder.)

2. Adjust the BURST amplitude control for .3 volts peak-to-peak burst. (40 IRE units.)

3. Adjust the RECORD PHASE coarse and fine controls for proper hues in a color picture observed on a monitor.

4. Without disturbing the settings as made in step 3, play back a test tape and adjust the PBLK PHASE control for the proper hues.

PANEL OPERATING CONTROLS

Module	*Panel Designation*	*Symbol Number*	*Function*
Input and Blanking	VID LEVEL	1R5	Adjusts video output
	PEDESTAL	1R25	Adjusts proper set-up
Output	SYNC LEVEL	3R16	Adjusts proper sync amplitude
Color	CHROMA	5R6	Adjusts chroma gain
	BURST	5R64	Adjusts burst amplitude
	RECORD PHASE	5S1, 5R50	Adjusts burst phase in the RECORD mode; coarse and fine adjustments.
	PBLK PHASE	5R45	Adjusts burst phase in PLAYBACK mode of system operation.

MAINTENANCE

The RCA Signal Processing Amplifier routine maintenance requires only the adjustment of a few front panel controls. Transistor circuits for all modules make the individual servicing of each module physically easy. When the rotary latch is released, each module may be removed for bench inspection if necessary. All parts and transistors are mounted flat against the main body or chassis of the module. However, the test points along the front panel of each module provide for routine testing without removal of the module. If additional tests with the circuits in operation seem advisable, the Extender has been supplied for mounting the module to be checked in operating condition but extending beyond the frame of the amplifier. All components are then easily accessible for oscilloscope or voltmeter probes.

Waveforms are provided for all test points figures SPA-39 thru SPA-44. Check the caption for each and the *Setup for Test Oscilloscope* paragraphs for information as to how they were taken. The waveforms keyed to the simplified schematics should also prove useful in complete checking of each module.

Front Panel Adjustments

1. To Adjust Voltage

a. On the front panel of Power 1 Module, −22V ADJ, 11R12, screwdriver adjustment controls the −22 volt and −9 volt outputs.

b. Adjust this voltage by turning the screwdriver control −22V ADJ until the meter, 11M1, reads −22 volts.

c. Adjustment of the -22 volt output automatically adjusts the -9 volt output.

d. Press the button marked READ -9V, 11S1; the meter reading should be -9 volts $\pm\frac{1}{2}$ volt.

2. To Adjust Master Oscillator in Horizontal AFC Module

An oscilloscope or a monitor triggered with external sync, such as the system Picture Monitor, may be used to adjust the center frequency of the master oscillator.

Using Oscilloscope

a. Observe the processing amplifier output on the CRO by pressing LINE OUT on CRO Monitor switcher.

b. Set the CRO to the H sweep rate with EXT sync.

c. Press the pushbutton 6S1 on the Horizontal AFC front panel. While holding the button down, adjust the 31.5 FREQ. SET, 6R7, until the pattern obtained is as nearly stationary as possible.

Using Picture Monitor

a. Observe the processing amplifier output on the Picture Monitor by pressing LINE OUT on the CRO Monitor Switcher.

b. Repeat step c above.

3. To Adjust Horizontal Blanking Width

a. To obtain the proper horizontal blanking width, connect an oscilloscope to one of the OUTPUTS 1, 2, 3 (3TP1, 3TP2, 3TP3) on the front panel of the Output Module.

b. Adjust the oscilloscope to display a single horizontal blanking interval.

c. Adjust the H. BLKG WIDTH control 9R33 on the front panel of the Sync Logic Module to give 11 microseconds horizontal blanking width.

4. To Adjust Vertical Blanking Width

a. To obtain the proper vertical blanking width, connect an oscilloscope to one of the OUTPUTS 1, 2, 3 (3TP1, 3TP2, 3TP3) on the front panel of the Output Module.

b. Using delayed sweep and triggering the oscilloscope with external sync (or 3.5H) adjust the oscilloscope to display the vertical blanking interval. Adjust the V. BLKG WIDTH control 9R1 on the front panel of the Sync Logic Module to give a vertical blanking width of 21H (1333.5 microseconds).

5. To Check Stability of Counter Multivibrators

A control STABILITY TEST, 8R30, and a pushbutton switch, 8S1, are mounted on the front panel of the Vertical Advance Module. When the pushbutton is depressed, the STABILITY TEST control is brought into the module circuit. By rotating this control, all of the counter multivibrator circuits are checked. If each is operating correctly, no change takes place in the multivibrator operation. However, if a multivibrator is near a condition of improper operation, rotation of the control causes it to go into improper operation. (Operation of the STABILITY TEST control also checks operation of the $\div 2$ multivibrator in the Horizontal AFC Module. However this is an extremely stable circuit because of the low order of division and does not require adjustment. Improper operation due to a part failure would be observed as an instability of the 31.5 kc master oscillator.)

The 3.5H pulse as shown in figure SPA-43E, is used to detect any improper operation of the Vertical Advance counter. The procedure for this test is as follows:

a. Place the tape recorder machine in the MOD-DEMOD mode of operation.

b. Place the CRO selector switch in TEST position and connect an external probe to the 3.5H test point on the Vertical Advance Module.

c. Set the CRO sweep speed to V and expand the trace to observe the 3.5H pulse.

d. Press the button 8S1; while holding the button depressed, rotate the STABILITY TEST control through its entire range. The pulse should not change in any respect. Minor disturbances, which may be observed on the base line, do not indicate improper operation.

e. If the pulse changes at any position of the control, the counters in the Vertical Advance Module must be adjusted. Refer to the *Adjustment of Counters* for the adjustment procedures.

Internal Adjustments

All of the following adjustments require the removal of the module from the frame and the use of the Extender.

1. Adjustment of Counters

In the Vertical Advance Module, the counters, the 3.5H pulse and the start pulse form a continuous loop which makes it difficult, when the STABILITY TEST pushbutton is pressed and a marginal counter is indicated, to determine which counter is at fault. The fol-

lowing procedure provides a method for identifying and correcting a marginal or defective counter:

> NOTE: The adjustment of the ÷2 MV is a precautionary step which may be omitted if the operator is reasonably certain that the Horizontal AFC Module is functioning properly.

a. With the Horizontal AFC Module in the Extender, put an oscilloscope probe (oscilloscope in internal trigger) at the emitter of 6Q8, which is the source of 31.5 kc pulses from the master oscillator to the ÷2 multivibrator 6Q9, 6Q10. Adjust the oscilloscope sweep so that two 31.5 kc pulses cover 10 cm on the oscilloscope. Then move the probe to the ÷2 test point. One cycle of the ÷2MV should be 10 cm wide; if not a failure in the Horizontal AFC Module is indicated. This failure must be corrected before attempting to adjust the Vertical Advance Module. If the ÷2 counter cycle shows the proper width, depress the STABILITY TEST pushbutton in the Vertical Advance Module and rotate the stability test knob through its range. The ÷2 counter width should not change at any position of the knob. The ÷2 counter must pass this test before adjustment of the Vertical Advance Module counters can be undertaken.

b. Remove the collector lead of 8Q12 from the terminal, see figure SPA-49, leaving the jumper and diode 8CR8 connections on the terminal. This opens the loop and allows the counters to run free.

c. With the module in the extender, put an oscilloscope probe (oscilloscope on internal trigger) on pin 1 of the connector 8J8, the 31.5 kc input to the Vertical Advance Module.

d. Adjust the sweep so that seven 31.5 kc pulses cover 10 cm on the oscilloscope. Then move the probe to the ÷7 test point. One cycle of the ÷7MV should be 10 cm (seven 31.5 kc pulses) wide. If it is not, adjust 8R1 until the cycle measures 10 cm.

e. Push the STABILITY TEST pushbutton and run the knob through its range. The width of the ÷7 cycle should not change.

f. Change the oscilloscope sweep so that five ÷7 pulses cover 10 cm on the oscilloscope. Move the probe to the *first* ÷5 test point. One cycle of the ÷5MV should be 10 cm (five ÷7 pulses) wide. When this is accomplished, by adjusting 8R12, run through the stability test again with the probe remaining on the *first* ÷5 test point.

g. Change the oscilloscope sweep so that five ÷5 pulses cover 10 cm on the oscilloscope. Move the probe to the *second* ÷5 test point. One cycle of this MV should be 10 cm wide (the width of five of the *first* ÷5 pulses). When this is accomplished, by adjusting 8R20, run through the stability test with the probe remaining on the *second* ÷5 test point.

h. Change the sweep again so that three of the *second* ÷5 pulses cover 10 cm on the oscilloscope. Move the probe to the ÷3 test point. One cycle of the ÷3MV should be 10 cm wide (the width of three of the *second* ÷5 pulses). When this is accomplished, by adjusting 8R55, run through the stability test with the probe remaining on the ÷3 test point.

> NOTE: With a dual trace oscilloscope, the above procedure is somewhat simplified since the output of each counter may be compared directly to the output of the preceding stage. It is not necessary to setup to an arbitrary 10 cm scale.

i. Reconnect the collector of 8Q12 to its terminal and replace the module in the frame.

j Check the stability according to the procedure in step 5 of *Front Panel Adjustments.*

NOTES

1. Proper counter operation is necessary but not sufficient to insure proper vertical advance. In some cases proper counting may be obtained with the collector of 8Q12 lifted; however, when the loop is closed again by reconnecting 8Q12, improper advance is obtained. This condition results from improper off-time width of one of the counters, usually the second ÷5 MV. To detect the offending counter, locate the leading edge of the 3.5H pulse (which will be much wider than normal). The leading edge lines up with the turn-off time of the offending counter. When the counter has been located readjust its timing so as to lengthen its period. A point will be found where the counting chain jumps suddenly into proper operation. Continue to lengthen its period until the counterchain holds to proper count throughout the range of the STABILITY TEST control.
2. A condition may be obtained in the Vertical Advance Module in which a blanking bar is generated on alternate fields instead of on every field. This results from having the ÷3 MV adjusted to have an excessively long time constant. The multivibrator cannot recover in time to be retriggered by the start pulse; therefore, it waits for one entire field before being retriggered. To cure this problem, simply readjust the ÷3 counter adjustment to shorten the time constant, checking the final setting to be certain that it passes the STABILITY TEST.
3. Sometimes a condition may be obtained in which the Horizontal AFC Module produces regenerated sync at 31.5 kc instead of 15.75 kc. A common cause of this fault is a shorted regulator transistor 8Q14 in the Vertical Advance Module. A quick check for this fault consists of measuring the —9 volt bus in the Vertical Advance Module. If the 8Q14 transistor is shorted, the bus is at an approximate potential of —17 volts.

2. To Remove Sync from OUT #1

a. Switch 3S1 is mounted on the side of the Output Module chassis, as a precaution against being accidentally operated.

b. To remove the sync from the OUTPUT #1, withdraw the module from the frame, place the switch in the SYNC OFF position and replace the module in the frame.

3. To Adjust Burst Width

a. Feed the Signal Processing Amplifier with a color signal from the TRT Tape Recorder System.

b. Connect an oscilloscope to one of the test points OUTPUTS 1, 2, 3 (3TP1, 3TP2, 3TP3) on the Output Module.

c. Adjust the oscilloscope to display a horizontal blanking interval.

d. Adjust the BURST WIDTH control, 5R75, on the subcarrier circuit side of the Color Module to obtain nine cycles of subcarrier in the burst interval.

4. To Adjust Front Porch Width

a. Connect an oscilloscope to one of the test points, OUTPUTS 1, 2, 3 (3TP1, 3TP2, 3TP3) on the Output Module.

b. Adjust the oscilloscope to display a horizontal blanking interval.

c. Adjust the Front Porch Width control, 6R52, on the side of the Horizontal AFC Module to obtain a front porch width of 1.7 microseconds.

5. To Adjust Sync Width

a. Connect an oscilloscope to one of the test points OUTPUTS 1, 2, 3 (3TP1, 3TP2, 3TP3) on the Output Module.

b. Adjust the oscilloscope to display a horizontal blanking interval.

c. Adjust the Horizontal Sync Width control, 6R37, on the side of the Horizontal AFC Module to obtain a horizontal sync pulse 4.76 microseconds wide.

6. To Adjust Sync Timing

a. Connect input 1 of a dual trace oscilloscope to the incoming separated sync and connect input 2 to one of the outputs of the Output Module.

b. Lock the oscilloscope externally at a horizontal rate.

c. Adjust the sync timing control on the side of the Horizontal AFC Module so that sync on the output signal precedes separated sync by .5 microseconds.

To Setup Oscilloscope for Waveforms

All of the waveform illustrations were made with the Type 535 oscilloscope setup as follows:

1. Place the Tape Recorder System in the SETUP position on the Control Panel, unit 305.

2. Connect the EXT. SYNC trigger of the B trace of the oscilloscope to the 9H test point of the module.

3. Use the A DELAYED BY B position to expand the B trace to show detail and timing.

4. Set the A TIMING as indicated for each.

5. The vertical input to the oscilloscope should be set to DC to obtain the reference voltages shown in the photographs. In photographs where a second waveform is shown for a timing reference, DC voltage reference does not apply to that waveform.

Replacement of Transistors

When a defective transistor is indicated, be sure to observe all of the following precautions for the removal and replacement of transistors:

1. Remove power before removing or replacing a transistor.

2. Avoid improper insertion of the replacement transistor.

3. AVOID EXCESSIVE HEAT.

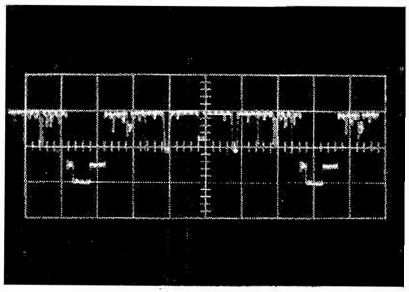
4. Use a small soldering iron. Use long nose pliers as a heat sink on the transistor lead between the point being soldered and the transistor.

5. DO NOT USE RX1 scale of the ohmmeter; junction could be damaged.

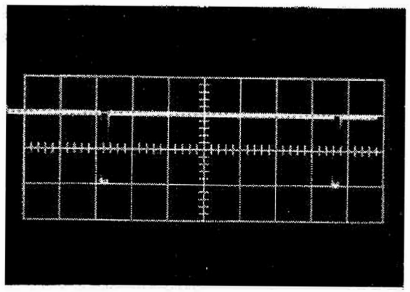
6. Avoid accidental short circuits. Note that there is no warning of a short as in the tube circuit.

TRANSISTOR COMPLEMENT

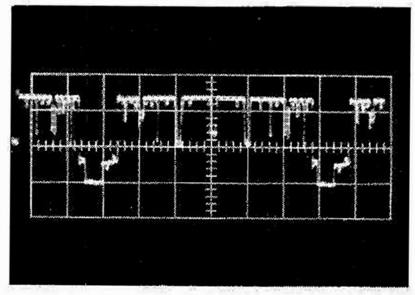
Symbol	Type	Function	Symbol	Type	Function
Input and Blanking Module					
1Q1	2N1143	Video Amplifier	1Q6	2N404	Blanking Adder
1Q2	2N1143	Emitter Follower	1Q10	2N1090	Clamp Pulse Delay
1Q3	2N1301	Feedback Amplifier	1Q11	2N404	Clamp Driver
1Q4	2N1143	Feedback Amplifier	1Q14	2N1090	Clamp Pulse Amplifier
1Q5	2N1301	Emitter Follower			
Output Module					
3Q1	2N1301	Black Clipper	3Q7	2N1301	Amplifier
3Q2	2N1301	Color Adder	3Q8	2N1301	Amplifier
3Q3	2N1091	Sync Output	3Q9	2N1301	Amplifier
3Q4	2N1091	Sync Adder	3Q10	2N1301	Amplifier
3Q5	2N1301	Driver	3Q11	2N1301	Amplifier
3Q6	2N1301	Driver	3Q12	2N1301	Amplifier
Color Module					
5Q1	2N1301	Color Amplifier	5Q9	2N1224	Rec. Phase Isolator
5Q2	2N1301	Chroma Amplifier	5Q10	2N1224	Subcarrier Amplifier
5Q3	2N1301	Chroma Amplifier	5Q11	2N1224	Clipper Driver
5Q4	2N1301	Clamp Driver	5Q12	2N1224	Subcarrier Output
5Q5	2N1301	Clamp Driver	5Q13	2N1090	Burst Gate
5Q6	2N1224	Subcarrier Amplifier	5Q14	2N1301	Burst Output
5Q7	2N1301	Transformer Driver	5Q15	2N1090	Burst Flag Generator
5Q8	2N1224	Isolator	5Q16	2N1090	Gate Driver
Horizontal AFC Module					
6Q1	2N404	31.5 Kc Master Oscillator	6Q9	2N404	÷2 Multivibrator
6Q2	2N404		6Q10	2N404	
6Q3	2N1417	AFC Amplifier	6Q11	2N404	Front Porch Delay Generator
6Q4	2N1090	Clamp Driver	6Q12	2N404	Horizontal Sync Generator
6Q5	2N1090	Clamp Pulse Generator	6Q13	2N404	Sawtooth Generator
6Q6	2N404	Clipper	6Q14	2N404	Complementary Symmetry (Bootstrap)
6Q7	2N404	Sawtooth Generator	6Q15	2N1090	
6Q8	2N1090	Trigger Amplifier	6Q16	2N404	Equalizing Pulse Gate
Vertical Advance Module					
8Q1	2N404	÷7 Multivibrator	8Q8	2N404	÷3 Multivibrator
8Q2	2N1090		8Q9	2N1090	
8Q3	2N595	Bi-Directional Trigger	8Q10	2N1090	3.5H Amplifier
			8Q11	2N404	Start Pulse Amplifier
8Q4	2N404	÷5 Multivibrator #1	8Q12	2N1090	Gate Driver
8Q5	2N1090		8Q13	2N1090	Trigger Gate
			8Q14	2N1183	Power Supply Regulator
8Q6	2N404	÷5 Multivibrator #2			
8Q7	2N1090				
Sync Logic Module					
9Q1	2N404	Vertical Blanking Multivibrator	9Q7	2N1090	Gated Horizontal Amplifier
9Q2	2N404		9Q8	2N1301	Regenerated Sync Amplifier
			9Q9	2N1090	Integrator Driver
9Q3	2N404	9-H Generator	9Q10	2N1090	Start Pulse Clipper
9Q4	2N1090	9-H Amplifier	9Q11	2N404	Blanking Mixer
9Q5	2N1090	Vertical Interval Gate	9Q12	2N404	Horizontal Drive Generator
9Q6	2N404	Horizontal Sync Gate	9Q13	2N404	Horizontal Drive Output
Power Supply 1 Module					
11Q1	2N1183	DC Amplifier	11Q4	2N404	DC Amplifier
11Q2	2N332	Current Source	11Q5	2N1183	DC Amplifier
11Q3	2N404	DC Amplifier	11Q6	2N404	DC Amplifier
Power Supply 2 Module					
12Q1	2N1183	Series Regulator	12Q2	2N301	Series Regulator



A. VIDEO IN, 1TP1; .5v/division.

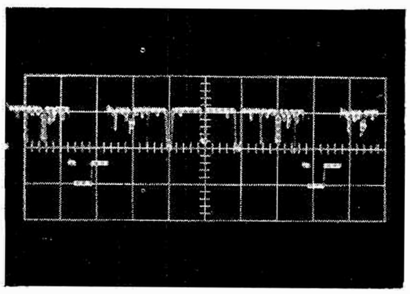


B. CLAMP PULSE, 1TP2; 5v/division.

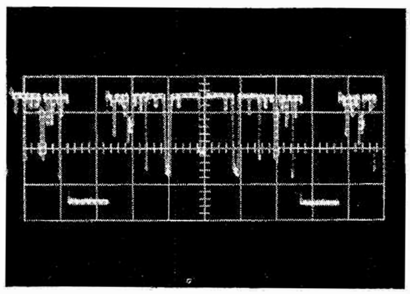


C. 3.5V VID, 1TP3; 2v/division.

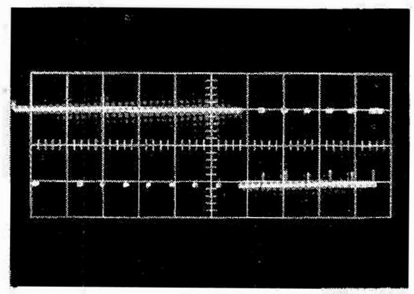
Figure SPA-39. Waveforms for Test Points on Input and Blanking Module Panel



A. OUTPUTS #1, #2, #3, 3TP1, 3TP2, 3TP3; .5v/division.

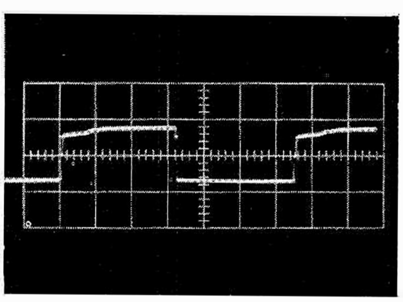


B. VID IN 3TP5; .5v/division.

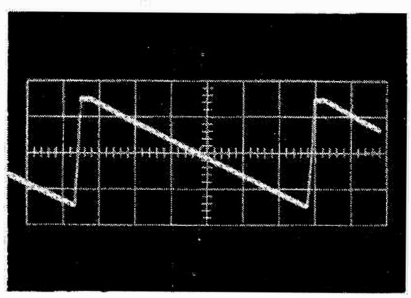


C. SYNC OUT, 3TP6; 2v/division.

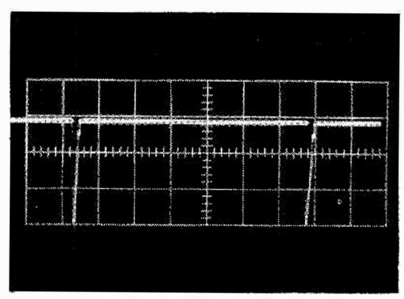
Figure SPA-40. Waveforms for Test Points on Output Module Panel



A. ÷2, 6TP1; 5v/division.

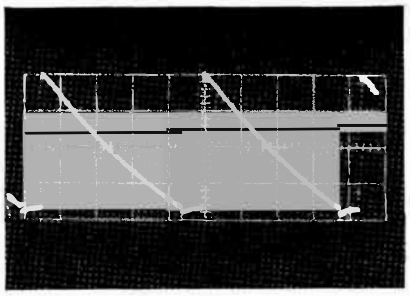


B. AFC SAW, 6TP2; 5v/division.

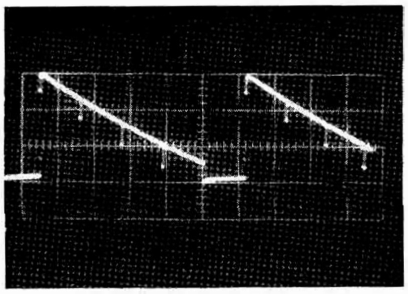


C. AFC PUL, 6TP3; 5v/division.

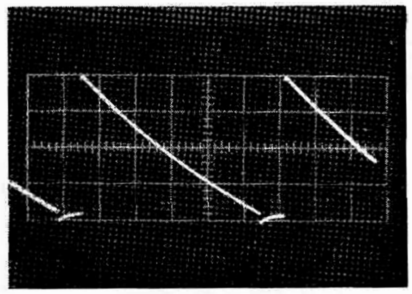
Figure SPA-41. Waveforms for Test Points on Horizontal AFC Module Panel



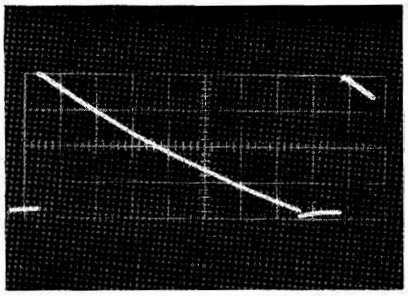
A. ÷7, 8TP1; 2v/division at 50 microseconds/cm.



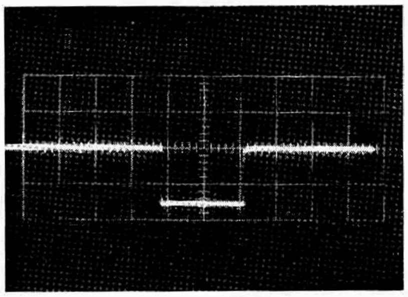
B. ÷5, 8TP2; 2v/division at 200 microseconds/cm.



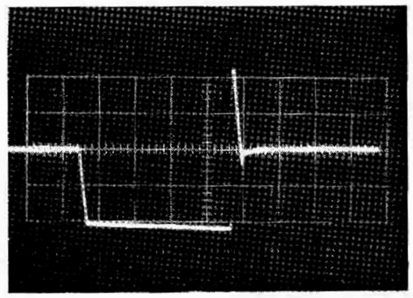
C. ÷5, 8TP3; 2v/division at 1000 microseconds/cm.



D. ÷3, 8TP4; 2v/division at 2000 microseconds/cm.

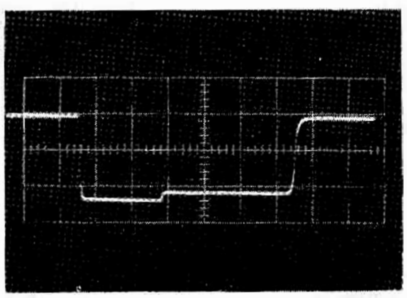


E. 3.5H, 8TP5; 5v/division at 100 microseconds/cm.

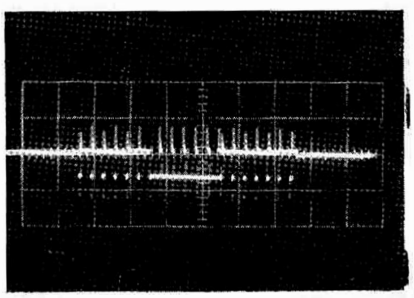


F. START PULSE, 8TP6; 1v/division, at 50 microseconds/cm.

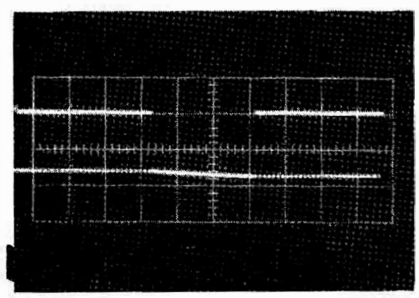
Figure SPA-42. Waveforms for Test Points on Vertical Advance Module Panel



A. 9H, 9TP1; 2v/division.

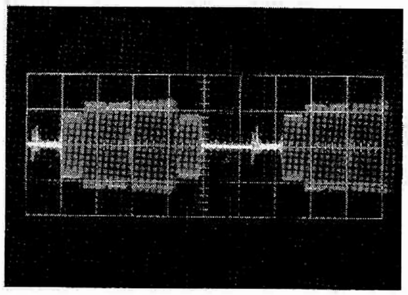


B. SYNC GATE, 9TP2; 2v/division.

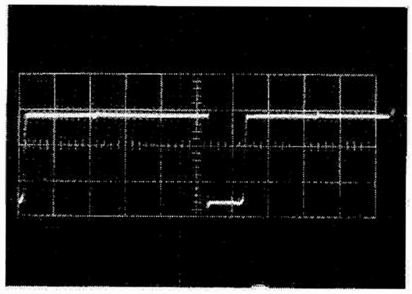


C. BL, 9TP3; 5v/division.

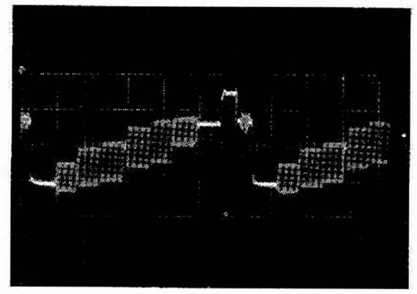
Figure SPA-43. Waveforms for Test Points on Sync Logic Module Panel



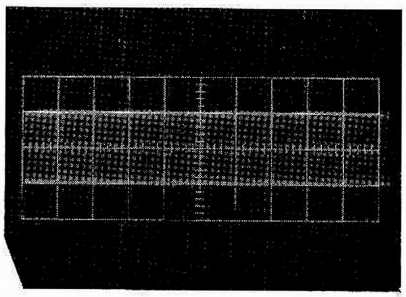
A. CHR (CHROME OUT) 5TP1; 1v/division.



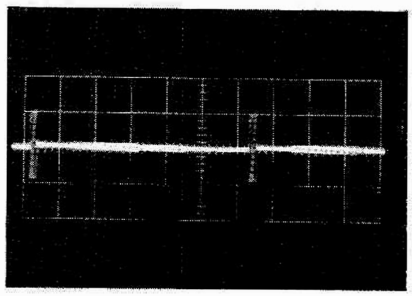
B. BL, 5TP2; .2v/division.



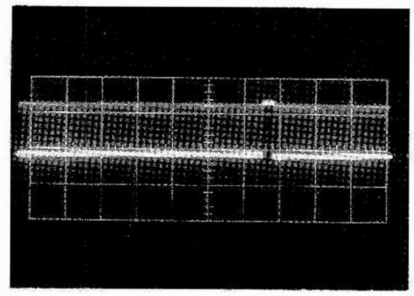
C. VID, 5TP3; .2v/division.



D. 3.58 IN, 5TP4; 1v/division.



E. BURST, 5TP5; .5v/division.



F. SYNC, 5TP6; 2v/division.

Figure SPA-44. Waveforms for Test Points on Color Module Panel

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
FRAME ASSEMBLY, 8511338-501			3
J1	221267	8414862-54	Connector: female, 24 contact
J2			Not Used
J3	221267	8414862-54	Connector: female, 24 contact
J4			Not Used
J5,J6	221267	8414862-54	Connector: female, 24 contact
J7			Not Used
J8,J9	221267	8414862-54	Connector: female, 24 contact
J10			Not Used
J11,J12	221267	8414862-54	Connector: female, 24 contact
J13	55806	727969-7	Connector: male, 8 contact
J14 to J25	51800	255223-2	Connector: female, coaxial, chassis mtg.
K1	218949	470678-10	Relay: 24 v D.C. S.P.D.T. (with 4 microswitches)
	216822		Switch - micro, for K1 relay
R1		82283-132	Resistor: fixed, comp., 75 ohms, ±5%, ½ w
R2			Not Used
R3		82283-132	Resistor: fixed, comp., 75 ohms, ±5%, ½ w
INPUT AND BLANKING UNIT, 8511323-501			5
			CAPACITORS:
1C1,1C2	219040	8959154-181	electrolytic, 100 μf, 12 v
1C3,1C4	108020	8959154-114	electrolytic, 100 μf, 25 v
1C5	56694	8979722-8	paper, 1 μf ±20%, 200 v
1C6,1C7	217350	8959154-108	electrolytic, 10 μf 25 v
1C8	221890	8959154-101	electrolytic, 1 μf 25 v
1C9		8914319-304	mica, 27 $\mu\mu$f ±5%, 500 v char "E"
1C10	108020	8959154-114	electrolytic, 100 μf 25 v
1C11	217350	8959154-108	electrolytic, 10 μf 25 v
1C12 to 1C15			Not Used
1C16		8914319-341	mica, 510 $\mu\mu$f ±5%, 300 v char "F"
1C17 to 1C22			Not Used
1C23		8914319-340	mica, 470 $\mu\mu$f ±5%, 300 v char "F"
1C24	108020	8959154-114	electrolytic, 100 μf 25 v
1C25	106552	8959154-184	electrolytic, 250 μf 12 v
1C26	223102	8983966-1	disc, 0.1 μf −30 +80%, 75 v
1C27		8914319-331	mica, 200 $\mu\mu$f ±5%, 500 v char "F"
1C28			Not Used
1C29	223102	8983966-1	disc, 0.1 μf −30 +80%, 75 v
1C30	108020	8959154-114	electrolytic, 100 μf 25 v
1C31	217350	8959154-108	electrolytic, 10 μf 25 v
1C32	106552	8959154-184	electrolytic, 250 μf 12 v
1CR1	207403		Rectifier: crystal diode 1N100
1J1	221268	8414862-4	Connector: male, 24 contact
1Q1,1Q2	221891		Transistor: 2N1143
1Q3	221856		Transistor: 2N1301
1Q4	221891		Transistor: 2N1143
1Q5	221856		Transistor: 2N1301
1Q6	223366		Transistor: 2N404
1Q7 to 1Q9			Not Used
1Q10	223367		Transistor: 2N1090
1Q11	223366		Transistor: 2N404
1Q12,1Q13			Not Used
1Q14	223367		Transistor: 2N1090
			RESISTORS:
			Fixed, Composition - Unless Otherwise Specified
1R1		82283-178	6200 ohms, ±5%, ½ w
1R2		82283-179	6800 ohms, ±5%, ½ w
1R3		82283-156	750 ohms, ±5%, ½ w
1R4		82283-166	2000 ohms, ±5%, ½ w
1R5	208656	8971860-8	variable, 2500 ohms, 2 w
1R6		82283-151	470 ohms, ±5%, ½ w
1R7			Not Used
1R8		82283-166	2000 ohms ±5%, ½ w
1R9		82283-141	180 ohms, ±5%, ½ w
1R10		82283-145	270 ohms, ±5%, ½ w
1R11		82283-169	2700 ohms, ±5%, ½ w
1R12		82283-161	1200 ohms, ±5%, ½ w
1R13		82283-154	620 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
1R14		82283-169	2700 ohms, ±5%, ½ w
1R15		82283-183	10,000 ohms, ±5%, ½ w
1R16		82283-128	51 ohms, ±5%, ½ w
1R17		82283-157	820 ohms, ±5%, ½ w
1R18, 1R19		82283-159	1000 ohms, ±5%, ½ w
1R20		82283-155	680 ohms, ±5%, ½ w
1R21		82283-160	1100 ohms, ±5%, ½ w
1R22		82283-181	8200 ohms, ±5%, ½ w
1R23		82283-170	3000 ohms, ±5%, ½ w
1R24		82283-154	620 ohms, ±5%, ½ w
1R25	208677	8971860-9	variable, 5000 ohms, 2 w
1R26		82283-171	3300 ohms, ±5%, ½ w
1R27 to 1R38			Not Used
1R39		82283-202	62,000 ohms, ±5%, ½ w
1R40		82283-171	3300 ohms, ±5%, ½ w
1R41		82283-146	300 ohms, ±5%, ½ w
1R42		82283-185	12,000 ohms, ±5%, ½ w
1R43		82283-146	300 ohms, ±5%, ½ w
1R44		82283-159	1000 ohms, ±5%, ½ w
1R45 to 1R55			Not Used
1R56, 1R57		82283-159	1000 ohms, ±5%, ½ w
1R58		82283-191	22,000 ohms, ±5%, ½ w
1TP1 to 1TP3	214603	8941099-4	Jack: tip, yellow
1XQ1, 1XQ2	221892	8707294-17	Socket: transistor
1XQ3			Not Used
1XQ4	221892	8707294-17	Socket: transistor
1Z1	221893	8728444-2	Quad: consisting of 4 matched diodes, encapsulated
			Miscellaneous:
	99385	8849946-7	Knob: red
OUTPUT UNIT, 8511322-501			
			CAPACITORS:
3C1	97639	458558-6	electrolytic, 1000 μf 25 v
3C2	108020	8959154-114	electrolytic, 100 μf 25 v
3C3	217350	8959154-108	electrolytic, 10 μf 25 v
3C4	219040	8959154-181	electrolytic, 100 μf 12 v
3C5	97639	458558-6	electrolytic, 1000 μf 25 v
3C6	219040	8959154-181	electrolytic, 100 μf 12 v
3C7, 3C8		8914319-340	mica, 470 μμf ±5%, 300 v char "F"
3C9 to 3C12	108020	8959154-114	electrolytic, 100 μf 25 v
3C13 to 3C15	211767	458558-28	electrolytic, 3000 μf 15 v
3C16, 3C17	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
3C18, 3C19	56694	8979722-8	paper, 1 μf ±20%, 200 v
3CR1	207403		Rectifier: crystal diode 1N100
3J1	221268	8414862-4	Connector: male, 24 contacts
			RESISTORS:
			Fixed, Composition - unless otherwise specified
3R1		99126-126	43 ohms, ±5%, 2 w
3R2		82283-132	75 ohms, ±5%, ½ w
3R3		82283-159	1000 ohms, ±5%, ½ w
3R4		82283-111	10 ohms, ±5%, ½ w
3R5		82283-150	430 ohms, ±5%, ½ w
3R6		82283-159	1000 ohms, ±5%, ½ w
3R7, 3R8		82283-163	1500 ohms, ±5%, ½ w
3R9		82283-149	390 ohms, ±5%, ½ w
3R10		82283-146	300 ohms, ±5%, ½ w
3R11, 3R12		82283-161	1200 ohms, ±5%, ½ w
3R13		82283-178	6200 ohms, ±5%, ½ w
3R14		82283-166	2000 ohms, ±5%, ½ w
3R15		82283-163	1500 ohms, ±5%, ½ w
3R16	95244	8971860-2	variable, 100 ohms, 2 w

Symbol No.	Stock No.	Drawing No.	Description
3R17,3R18		82283-155	680 ohms, ±5%, ½ w
3R19,3R20		82283-142	200 ohms, ±5%, ½ w
3R21		82283-135	100 ohms, ±5%, ½ w
3R22,3R23		82283-155	680 ohms, ±5%, ½ w
3R24 to 3R26		82283-166	2000 ohms, ±5%, ½ w
3R27		82283-142	200 ohms, ±5%, ½ w
3R28		82283-131	68 ohms, ±5%, ½ w
3R29,3R30		82283-142	200 ohms, ±5%, ½ w
3R31		82283-131	68 ohms, ±5%, ½ w
3R32,3R33		82283-142	200 ohms, ±5%, ½ w
3R34		82283-131	68 ohms, ±5%, ½ w
3R35		82283-142	200 ohms, ±5%, ½ w
3R36		82283-143	220 ohms, ±5%, ½ w
3R37		82283-128	51 ohms, ±5%, ½ w
3S1	221269	8511365-1	Switch: toggle, S.P.D.T.
3TP1 to 3TP6	214603	8941099-4	Jack: tip, yellow
			Miscellaneous:
	99385	8849946-7	Knob: control, red, for 3R16
	18469	85558-3	Plate: capacitor mounting, for 3C1,3C5,3C13, 3C14 and 3C15
			COLOR MODULE, 8511326-501
			CAPACITORS:
5C1	221276	8511367-5	variable, ceramic, 7-45 μμf 500 v N300
5C2		8914319-332	mica, 220 μμf ±5%, 500 v char "F"
5C3	221890	8959154-101	electrolytic, 1 μf 25 v
5C4	221284	8980848-112	paper, 0.1 μf ±10%, 200 v
5C5			Not Used
5C6	221284	8980848-112	paper, 0.1 μf ±10%, 200 v
5C7	108020	8959154-114	electrolytic, 100 μf 25 v
5C8	219040	8959154-181	electrolytic, 100 μf 12 v
5C9	108020	8959154-114	electrolytic, 100 μf 25 v
5C10	221890	8959154-101	electrolytic, 1 μf 25 v
5C11		8811182-5	disc, 0.01 μf -10 +60%, 500 v
5C12	221284	8980848-112	paper, 0.1 μf ±10%, 200 v
5C13	108020	8959154-114	electrolytic, 100 μf 25 v
5C14	219040	8959154-181	electrolytic, 100 μf 12 v
5C15	217350	8959154-108	electrolytic, 10 μf 25 v
5C16			Not Used
5C17	108020	8959154-114	electrolytic, 100 μf 25 v
5C18	219040	8959154-181	electrolytic, 100 μf 12 v
5C19 to 5C21	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C22	108020	8959154-114	electrolytic, 100 μf 25 v
5C23	57602	984003-7	variable, ceramic, 4.5-25 μμf 500 v
5C24,5C25	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C26		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
5C27		8914319-332	mica, 220 μμf ±5%, 500 v char "F"
5C28		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
5C29,5C30	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C31	76872	8901210-11	variable, mica, 5-80 μμf 500 v
5C32		8914319-325	mica, 110 μμf ±5%, 500 v char "F"
5C33	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C34		8914319-325	mica, 110 μμf ±5%, 500 v char "F"
5C35	76872	8901210-11	variable, mica, 5-80 μμf 500 v
5C36,5C37	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C38		8914319-325	mica, 110 μμf ±5%, 500 v char "F"
5C39	76872	8901210-11	variable, mica, 5-80 μμf 500 v
5C40 to 5C49	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
5C50		8914319-327	mica, 130 μμf ±5%, 500 v char "F"
5C51	219040	8959154-181	electrolytic, 100 μf 12 v
5C52,5C53			Not Used
5C54			Part of 5C1

Symbol No.	Stock No.	Drawing No.	Description
5C55		8914319-332	mica, 220 $\mu\mu$f ±5%, 500 v char "F"
5C56		8914319-345	mica, 750 $\mu\mu$f ±5%, 300 v char "F"
5C57	217350	8959154-108	electrolytic, 10 μf 25 v
5C58	108020	8959154-114	electrolytic, 100 μf 25 v
5C59		8914319-329	mica, 160 $\mu\mu$f ±5%, 500 v char "F"
5C60		8914319-328	mica, 150 $\mu\mu$f ±5%, 500 v char "F"
5C61		8914319-326	mica, 120 $\mu\mu$f ±5%, 500 v char "F"
5C62		8914319-335	mica, 300 $\mu\mu$f ±5%, 500 v char "F"
5CR1, 5CR2	218501	8983872-1	Rectifier: germanium diode
5CR3	215443		Rectifier: crystal diode 1N538
5CR4	207403		Rectifier: crystal diode 1N100
5J1	221268	8414862-4	Connector: male, 24 contacts
5K1	218165	470678-5	Relay: 24 v D.C. S.P.D.T. (with 2 microswitches)
	216822		Switch - micro, for 5K1
5K2	221280	8817527-4	Relay: 10,000 ohms, coil, S.P.D.T. plug in
5L1	99791	8825473-504	Coil: R.F. choke, 8 microhenry
5L2, 5L3	205878	8825473-502	Coil: R.F. choke, 4 microhenry
5L5 to 5L6	205518	8825473-507	Coil: R.F. choke, 20 microhenry
5L7			Not Used
5L8	213197	476933-3	Coil: peaking, 5-9 microhenry
5L9	99791	8825473-504	Coil: R.F. choke, 8 microhenry
			RESISTORS:
			Fixed, Composition - unless otherwise specified
5R1		82283-141	180 ohms, ±5%, ½ w
5R2		82283-169	2700 ohms, ±5%, ½ w
5R3		82283-165	1800 ohms, ±5%, ½ w
5R4		82283-169	2700 ohms, ±5%, ½ w
5R5		82283-127	47 ohms, ±5%, ½ w
5R6	206913	8971860-6	variable, 1000 ohms, 2 w
5R7		82283-161	1200 ohms, ±5%, ½ w
5R8		82283-178	6200 ohms, ±5%, ½ w
5R9		82283-143	220 ohms, ±5%, ½ w
5R10		82283-153	560 ohms, ±5%, ½ w
5R11		82283-159	1000 ohms, ±5%, ½ w
5R12		82283-167	2200 ohms, ±5%, ½ w
5R13		82283-137	120 ohms, ±5%, ½ w
5R14		82283-159	1000 ohms, ±5%, ½ w
5R15		82283-151	470 ohms, ±5%, ½ w
5R16, 5R17		82283-169	2700 ohms, ±5%, ½ w
5R18		82283-153	560 ohms, ±5%, ½ w
5R19		82283-145	270 ohms, ±5%, ½ w
5R20		82283-123	33 ohms, ±5%, ½ w
5R21		82283-167	2200 ohms, ±5%, ½ w
5R22		82283-159	1000 ohms, ±5%, ½ w
5R23		82283-137	120 ohms, ±5%, ½ w
5R24		82283-159	1000 ohms, ±5%, ½ w
5R25		82283-151	470 ohms, ±5%, ½ w
5R26		82283-159	1000 ohms, ±5%, ½ w
5R27, 5R28		82283-123	33 ohms, ±5%, ½ w
5R29, 5R30			Not Used
5R31, 5R32		82283-195	33,000 ohms, ±5%, ½ w
5R33		82283-141	180 ohms, ±5%, ½ w
5R34		82283-163	1500 ohms, ±5%, ½ w
5R35		82283-198	43,000 ohms, ±5%, ½ w
5R36		82283-182	9100 ohms, ±5%, ½ w
5R37		82283-156	750 ohms, ±5%, ½ w
5R38		82283-158	910 ohms, ±5%, ½ w
5R39		82283-179	6800 ohms, ±5%, ½ w
5R40, 5R41		82283-189	18,000 ohms, ±5%, ½ w
5R42		82283-160	1100 ohms, ±5%, ½ w
5R43		82283-231	1 meg ±5%, ½ w
5R44		82283-143	220 ohms, ±5%, ½ w
5R45	206913	8971860-6	variable, 1000 ohms, 2 w
5R46, 5R47		82283-189	18,000 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
5R48		82283-160	1100 ohms, ±5%, ½ w
5R49		82283-139	150 ohms, ±5%, ½ w
5R50	206913	8971860-6	variable, 1000 ohms, 2 w
5R51		82283-231	1 meg ±5%, ½ w
5R52, 5R53		82283-189	18,000 ohms, ±5%, ½ w
5R54		82283-167	2200 ohms, ±5%, ½ w
5R55		82283-191	22,000 ohms, ±5%, ½ w
5R56		82283-175	4700 ohms, ±5%, ½ w
5R57		82283-163	1500 ohms, ±5%, ½ w
5R58		82283-136	110 ohms, ±5%, ½ w
5R59		82283-147	330 ohms, ±5%, ½ w
5R60, 5R61		82283-189	18,000 ohms, ±5%, ½ w
5R62		82283-167	2200 ohms, ±5%, ½ w
5R63		82283-145	270 ohms, ±5%, ½ w
5R64	208656	8971860-8	variable, 2500 ohms, 2 w
5R65		82283-183	10,000 ohms, ±5%, ½ w
5R66		82283-147	330 ohms, ±5%, ½ w
5R67		82283-150	430 ohms, ±5%, ½ w
5R68		82283-159	1000 ohms, ±5%, ½ w
5R69		82283-141	180 ohms, ±5%, ½ w
5R70 to 5R72			Not Used
5R73		82283-166	2000 ohms, ±5%, ½ w
5R74		82283-192	24,000 ohms, ±5%, ½ w
5R75	221281	8980004-23	variable, 5000 ohms, ¼ w
5R76		82283-171	3300 ohms, ±5%, ½ w
5R77		82283-163	1500 ohms, ±5%, ½ w
5R78		82283-171	3300 ohms, ±5%, ½ w
5R79		82283-159	1000 ohms, ±5%, ½ w
5R80		82283-167	2200 ohms, ±5%, ½ w
5R81		82283-159	1000 ohms, ±5%, ½ w
5R82		82283-171	3300 ohms, ±5%, ½ w
5R83		82283-135	100 ohms, ±5%, ½ w
5R84		82283-157	820 ohms, ±5%, ½ w
5R85		82283-150	430 ohms, ±5%, ½ w
5R86		82283-193	27,000 ohms, ±5%, ½ w
5S1		8511374-1	Switch: rotary, 4 circuit, 5 pos. 2 sec. Centralab #PS-111
5T1	221283	8449595-501	Transformer
5TP1 to 5TP6	214603	8941099-4	Jack: tip, yellow
5Z1, 5Z2	221894	8728444-1	Quad: consisting of 4 matched diodes, encapsulated
			Miscellaneous:
	205329	741622-501	Knob: control, black
	208256	737867-106	Socket: 7 pin, for 5K2
HORIZONTAL AFC UNIT, 8511308-501			6
			CAPACITORS:
6C1	221890	8959154-101	electrolytic, 1 μf 25 v
6C2, 6C3	221895	8924416-124	mica, 4300 μμf ±1%, 300 v char "F"
6C4	221890	8959154-101	electrolytic, 1 μf 25 v
6C5	106552	8959154-184	electrolytic, 250 μf 12 v
6C6	217350	8959154-108	electrolytic, 10 μf 25 v
6C7	221904	8980848-118	paper, 0.33 μf ±10%, 200 v
6C8, 6C9	217350	8959154-108	electrolytic, 10 μf 25 v
6C10		8924416-312	mica, 1200 μμf ±5%, 500 v char "F"
6C11	106114	8959154-122	electrolytic, 10 μf 6 v
6C12		8924416-325	mica, 4700 μμf ±5%, 300 v char "F"
6C13		8914319-345	mica, 750 μμf ±5%, 300 v char "F"
6C14		8924416-314	mica, 1500 μμf ±5%, 500 v char "F"
6C15	216712	8959154-167	electrolytic, 1 μf 12 v
6C16	221896	8980848-100	paper, 0.01 μf ±10%, 200 v
6C17		8914319-326	mica, 120 μμf ±5%, 500 v char "F"
6C18		8924416-325	mica, 4700 μμf ±5%, 300 v char "F"

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
6C19		8914319-329	mica, 160 $\mu\mu$f ±5%, 500 v char "F"
6C20	221890	8959154-101	electrolytic, 1 μf 25 v
6C21	217350	8959154-108	electrolytic, 10 μf 25 v
6C22	219039	8959154-110	electrolytic, 25 μf 25 v
6C23		8924416-324	mica, 4300 $\mu\mu$f ±5%, 300 v char "F"
6C24	218615	8959154-174	electrolytic, 10 μf 12 v
6C25	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
6C26	221896	8980848-100	paper, 0.01 μf ±10%, 200 v
6C27, 6C28	217350	8959154-108	electrolytic, 10 μf 25 v
6C29		8914319-340	mica, 470 $\mu\mu$f ±5%, 300 v char "F"
6J1	221268	8414862-4	Connector: male, 24 contacts
6Q3	221897		Transistor: 2N1417
			RESISTORS:
			Fixed, Composition - unless otherwise specified
6R1	221898	990724-285	film, 750 ohms, ±1%, 1/8 w
6R2, 6R3		82283-159	1000 ohms, ±5%, ½ w
6R4	221898	990724-285	film, 750 ohms, ±1%, 1/8 w
6R5, 6R6	219942	990724-421	film, 16,200 ohms, ±1%, 1/8 w
6R7	98956	8971860-106	variable, 1000 ohms, 2 w
6R8, 6R9	218517	8513655-330	film, 2000 ohms, ±1%, 1/8 w
6R10		82283-123	33 ohms, ±5%, ½ w
6R11		82283-127	47 ohms, ±5%, ½ w
6R12		82283-186	13,000 ohms, ±5%, ½ w
6R13		82283-140	160 ohms, ±5%, ½ w
6R14		82283-195	33,000 ohms, ±5%, ½ w
6R15		82283-183	10,000 ohms, ±5%, ½ w
6R16		82283-166	2000 ohms, ±5%, ½ w
6R17		82283-145	270 ohms, ±5%, ½ w
6R18			Not Used
6R19		82283-145	270 ohms, ±5%, ½ w
6R20		82283-167	2200 ohms, ±5%, ½ w
6R21	221899	990724-385	film, 7500 ohms, ±1%, 1/8 w
6R22		82283-167	2200 ohms, ±5%, ½ w
6R23		82283-187	15,000 ohms, ±5%, ½ w
6R24		82283-111	10 ohms, ±5%, ½ w
6R25		82283-156	750 ohms, ±5%, ½ w
6R26		82283-159	1000 ohms, ±5%, ½ w
6R27		82283-175	4700 ohms, ±5%, ½ w
6R28, 6R29		82283-176	5100 ohms, ±5%, ½ w
6R30	221666	990724-377	film, 6190 ohms, ±1%, 1/8 w
6R31		82283-171	3300 ohms, ±5%, ½ w
6R32		82283-159	1000 ohms, ±5%, ½ w
6R33		82283-135	100 ohms, ±5%, ½ w
6R34		82283-145	270 ohms, ±5%, ½ w
6R35		82283-155	680 ohms, ±5%, ½ w
6R36		82283-161	1200 ohms, ±5%, ½ w
6R37	221281	8980004-23	variable, 5000 ohms, ¼ w
6R38	221900	990724-321	film, 1620 ohms, ±1%, 1/8 w
6R39		82283-159	1000 ohms, ±5%, ½ w
6R40		82283-170	3000 ohms, ±5%, ½ w
6R41		82283-175	4700 ohms, ±5%, ½ w
6R42		82283-152	510 ohms, ±5%, ½ w
6R43, 6R44		82283-175	4700 ohms, ±5%, ½ w
6R45		82283-167	2200 ohms, ±5%, ½ w
6R46		82283-135	100 ohms, ±5%, ½ w
6R47		82283-139	150 ohms, ±5%, ½ w
6R48		82283-170	3000 ohms, ±5%, ½ w
6R49		82283-167	2200 ohms, ±5%, ½ w
6R50			Not Used
6R51		82283-111	10 ohms, ±5%, ½ w
6R52	221281	8980004-23	variable, 5000 ohms, ¼ w
6R53		82283-161	1200 ohms, ±5%, ½ w
6R54	221281	8980004-23	variable, 5000 ohms, ¼ w
6R55		82283-167	2200 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
6S1	221273	8511366-1	Switch: push-button, S.P.D.T.
6TP1 to 6TP3	214603	8941099-4	Jack: tip, yellow
6Z1	221893	8728444-2	Quad: consisting of 4 matched diodes, encapuslated
VERTICAL ADVANCE UNIT, 8511068-501			
			CAPACITORS:
8C1	221901	8980848-108	paper, 0.047 μf ±10%, 200 v
8C2	106552	8959154-184	electrolytic, 250 μf 12 v
8C3		8924416-312	mica, 1200 μμf ±5%, 500 v char "F"
8C4		8924416-318	mica, 2400 μμf ±5%, 500 v char "F"
8C5	106054	8959154-177	electrolytic, 25 μf 12 v
8C6	106552	8959154-184	electrolytic, 250 μf 12 v
8C7		8924416-318	mica, 2400 μμf ±5%, 500 v char "F"
8C8	221902	8980848-122	paper, 0.68 μf ±10%, 200 v
8C9	106552	8959154-184	electrolytic, 250 μf 12 v
8C10		8924416-324	mica, 4300 μμf ±5%, 300 v char "F"
8C11	106054	8959154-177	electrolytic, 25 μf 12 v
8C12	221903	8980848-126	paper, 2 μf ±10%, 200 v
8C13	106552	8959154-184	electrolytic, 250 μf 12 v
8C14	106054	8959154-177	electrolytic, 25 μf 12 v
8C15	216712	8959154-167	electrolytic, 1 μf 12 v
8C16		8924416-316	mica, 1800 μμf ±5%, 500 v char "F"
8C17	221904	8980848-118	paper, 0.33 μf ±10%, 200 v
8C18	108020	8959154-114	electrolytic, 100 μf 25 v
8C19	99882	8511368-2	disc, 0.01 μf -40 +60%, 150 v
8CR1, 8CR2	207403		Rectifier: crystal diode, 1N100
8CR3 to 8CR5	218612		Rectifier: crystal diode, 1N2069
8CR6	207403		Rectifier: crystal diode, 1N100
8CR7	218612		Rectifier: crystal diode, 1N2069
8CR8 to 8CR10	207403		Rectifier: crystal diode, 1N100
8J1	221268	8414862-4	Connector: male, 24 contact
8Q3	221924		Transistor: 2N595
			RESISTORS:
			Fixed, Composition - unless otherwise specified
8R1	222297	8980004-22	variable, 2000 ohms, ¼ w
8R2	221905	8513655-365	film, 4640 ohms, ±1%, 1/8 w
8R3		82283-183	10,000 ohms, ±5%, ½ w
8R4		82283-162	1300 ohms, ±5%, ½ w
8R5	72067	867970-331	wire wound, 5.1 ohms, ±10%, ½ w
8R6		82283-135	100 ohms, ±5%, ½ w
8R7		82283-138	130 ohms, ±5%, ½ w
8R8		82283-159	1000 ohms, ±5%, ½ w
8R9		82283-135	100 ohms, ±5%, ½ w
8R10		82283-153	560 ohms, ±5%, ½ w
8R11		82283-142	200 ohms, ±5%, ½ w
8R12	222297	8980004-23	variable, 2000 ohms, ¼ w
8R13	221906	8513655-369	film, 5110 ohms, ±1%, 1/8 w
8R14		82283-183	10,000 ohms, ±5%, ½ w
8R15		82283-162	1300 ohms, ±5%, ½ w
8R16	72067	867970-331	wirewound, 5.1 ohms, ±10%, ½ w
8R17		82283-142	200 ohms, ±5%, ½ w
8R18		82283-119	22 ohms, ±5%, ½ w
8R19		82283-174	4300 ohms, ±5%, ½ w
8R20	222297	8980004-22	variable, 2000 ohms, ¼ w
8R21	221907	8513655-401	film, 10,000 ohms, ±1%, 1/8 w
8R22		82283-183	10,000 ohms, ±5%, ½ w
8R23		82283-162	1300 ohms, ±5%, ½ w
8R24		82283-142	200 ohms, ±5%, ½ w
8R25	72067	867970-331	wire wound, 5.1 ohms, ±10%, ½ w
8R26		82283-138	130 ohms, ±5%, ½ w
8R27	221908	990724-373	film, 5620 ohms, ±1%, 1/8 w
8R28		82283-111	10 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
8R29		82283-152	510 ohms, ±5%, ½ w
8R30	95245	8971860-4	variable, 250 ohms, 2 w
8R31		82283-140	160 ohms, ±5%, ½ w
8R32		82283-183	10,000 ohms, ±5%, ½ w
8R33		82283-162	1300 ohms, ±5%, ½ w
8R34		82283-142	200 ohms, ±5%, ½ w
8R35	72067	867970-331	wire wound, 5.1 ohms, ±10%, ½ w
8R36		82283-138	130 ohms, ±5%, ½ w
8R37		82283-191	22,000 ohms, ±5%, ½ w
8R38		82283-171	3300 ohms, ±5%, ½ w
8R39		82283-178	6200 ohms, ±5%, ½ w
8R40		82283-159	1000 ohms, ±5%, ½ w
8R41		82283-183	10,000 ohms, ±5%, ½ w
8R42, 8R43		82283-159	1000 ohms, ±5%, ½ w
8R44		82283-152	510 ohms, ±5%, ½ w
8R45		82283-169	2700 ohms, ±5%, ½ w
8R46		82283-159	1000 ohms, ±5%, ½ w
8R47		82283-147	330 ohms, ±5%, ½ w
8R48		82283-123	33 ohms, ±5%, ½ w
8R49		82283-174	4300 ohms, ±5%, ½ w
8R50 to 8R53		82283-135	100 ohms, ±5%, ½ w
8R54		82283-136	110 ohms, ±5%, ½ w
8R55	221281	8980004-23	variable, 5000 ohms, ¼ w
8R56		82283-207	100,000 ohms, ±5%, ½ w
8R57		82283-174	4300 ohms, ±5%, ½ w
8S1	221273	8511366-1	Switch: push-button, S.P.D.T.
8TP1 to 8TP6	214603	8941099-4	Jack: tip, yellow
			Miscellaneous:
	205329	741622-501	Knob: control
SYNC LOGIC UNIT, 8511069-501			
			CAPACITORS:
9C1	221909	8980848-120	paper, 0.47 μf ±10%, 200 v
9C2	221896	8980848-100	paper, 0.01 μf ±10%, 200 v
9C3	221910	8980848-116	paper, 0.22 μf ±10%, 200 v
9C4	106735	8959154-176	electrolytic, 20 μf 12 v
9C5		8914319-340	mica, 470 μμf ±5%, 300 v char "F"
9C6	221890	8959154-101	electrolytic, 1 μf 25 v
9C7	219039	8959154-110	electrolytic, 25 μf 25 v
9C8	219040	8959154-181	electrolytic, 100 μf 12 v
9C9	221911	8980848-124	paper, 1 μf ±10%, 200 v
9C10	221896	8980848-100	paper, 0.01 μf ±10%, 200 v
9C11		8924416-316	mica, 1800 μμf ±5%, 500 v char "F"
9C12		8924416-318	mica, 2400 μμf ±5%, 500 v char "F"
9C13	219040	8959154-181	electrolytic, 100 μf 12 v
9C14	221284	8980848-112	paper, 0.1 μf ±10%, 200 v
9C15		8914319-328	mica, 150 μμf ±5%, 500 v char "F"
9C16		8924416-325	mica, 4700 μμf ±5%, 300 v char "F"
9C17		8924416-321	mica, 3300 μμf ±5%, 500 v char "F"
9C18		8924416-326	mica, 5100 μμf ±5%, 300 v char "F"
9C19	221901	8980848-108	paper, 0.047 μf ±10%, 200 v
9CR1, 9CR2	207403		Rectifier: cyrstal diode 1N100
9CR3	218612		Rectifier: crystal diode 1N2069
9CR4 to 9CR9	207403		Rectifier: crystal diode 1N100
9CR10	218612		Rectifier: crystal diode 1N2069
9CR11, 9CR12	207403		Rectifier: crystal diode 1N100
9CR13	218612		Rectifier: crystal diode 1N2069
9CR14	207403		Rectifier: crystal diode 1N100
9J1	221268	8414862-4	Connector: male, 24 contact
			RESISTORS:
			Fixed, Composition - unless otherwise specified
9R1	56596	8971860-108	variable, 2500 ohms, 2 w
9R2		82283-174	4300 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
9R3		82283-161	1200 ohms, ±5%, ½ w
9R4, 9R5		82283-183	10,000 ohms, ±5%, ½ w
9R6		82283-163	1500 ohms, ±5%, ½ w
9R7		82283-139	150 ohms, ±5%, ½ w
9R8		82283-170	3000 ohms, ±5%, ½ w
9R9		82283-159	1000 ohms, ±5%, ½ w
9R10		82283-176	5100 ohms, ±5%, ½ w
9R11		82283-161	1200 ohms, ±5%, ½ w
9R12		82283-152	510 ohms, ±5%, ½ w
9R13		82283-175	4700 ohms, ±5%, ½ w
9R14		82283-165	1800 ohms, ±5%, ½ w
9R15		82283-171	3300 ohms, ±5%, ½ w
9R16		82283-166	2000 ohms, ±5%, ½ w
9R17		82283-178	6200 ohms, ±5%, ½ w
9R18		82283-175	4700 ohms, ±5%, ½ w
9R19		82283-157	820 ohms, ±5%, ½ w
9R20		82283-207	100,000 ohms, ±5%, ½ w
9R21		82283-183	10,000 ohms, ±5%, ½ w
9R22		82283-190	20,000 ohms, ±5%, ½ w
9R23		82283-147	330 ohms, ±5%, ½ w
9R24		82283-155	680 ohms, ±5%, ½ w
9R25		82283-175	4700 ohms, ±5%, ½ w
9R26		82283-144	240 ohms, ±5%, ½ w
9R27		82283-139	150 ohms, ±5%, ½ w
9R28		82283-159	1000 ohms, ±5%, ½ w
9R29		82283-185	12,000 ohms, ±5%, ½ w
9R30, 9R31		82283-191	22,000 ohms, ±5%, ½ w
9R32		82283-166	2000 ohms, ±5%, ½ w
9R33	57221	8971860-109	variable, 5000 ohms, 2 w
9R34	221908	990724-373	film, 5620 ohms, ±1%, 1/8 w
9R35		82283-165	1800 ohms, ±5%, ½ w
9R36		82283-140	160 ohms, ±5%, ½ w
9R37		82283-169	2700 ohms, ±5%, ½ w
9R38	221666	990724-377	film, 6190 ohms, ±1%, 1/8 w
9R39		82283-161	1200 ohms, ±5%, ½ w
9R40		82283-133	82 ohms, ±5%, ½ w
9R41		82283-159	1000 ohms, ±5%, ½ w
9R42		82283-135	100 ohms, ±5%, ½ w
9R43		82283-199	47,000 ohms, ±5%, ½ w
9R44		82283-177	5600 ohms, ±5%, ½ w
9TP1 to 9TP3	214603	8941099-4	Jack: tip, yellow
			POWER UNIT, 8511324-501
			CAPACITORS:
11C1, 11C2	97639	458558-6	electrolytic, 1000 μf 50 v
11C3	221913	458557-15	electrolytic, 150 μf 150 v
11C4	219039	8959154-110	electrolytic, 25 μf 25 v
11C5	221890	8959154-101	electrolytic, 1 μf 25 v
11C6	108020	8959154-114	electrolytic, 100 μf 25 v
11C7	106552	8959154-184	electrolytic, 250 μf 12 v
11C8	221890	8959154-101	electrolytic, 1 μf 25 v
11C9	223102	8983966-1	disc, 0.1 μf -30 +80%, 75 v
11CR1, 11CR2	221914		Rectifier: crystal diode 1N608
11CR3	221915		Rectifier: crystal diode 650C
11CR4	221916		Rectifier: crystal diode SV3170
11F1	212875	990171-11	Fuse: 1 amp
11F2	47662	990171-9	Fuse: 0.5 amp
11F3	221917	990171-10	Fuse: 0.75 amp
11J1	221268	8414862-4	Connector: male, 24 contacts
11M1	221272	8511359-1	Meter: 0-30 v D.C.
11Q2	221918		Transistor: 2N332
			RESISTORS:
			Fixed, Composition - unless otherwise specified
11R1	221919	867970-9	wire wound, 0.51 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
11R2	221920	458572-2	wire wound, 5 ohms, ±5%, 5 w
11R3	95880	458574-4	wire wound, 20 ohms, ±5%, 10 w
11R4		90496-139	150 ohms, ±5%, 1 w
11R5		82283-139	150 ohms, ±5%, ½ w
11R6		82283-163	1500 ohms, ±5%, ½ w
11R7		82283-183	10,000 ohms, ±5%, ½ w
11R8		82283-163	1500 ohms, ±5%, ½ w
11R9		82283-151	470 ohms, ±5%, ½ w
11R10		82283-162	1300 ohms, ±5%, ½ w
11R11	221668	990724-349	film, 3160 ohms, ±1%, 1/8 w
11R12	98221	8971860-105	variable, 500 ohms, 2 w
11R13	221921	990724-312	film, 1300 ohms, ±1%, 1/8 w
11R14			Not Used
11R15	215173	990727-341	film, 2610 ohms, ±1%, 1/4 w
11R16	221922	990727-317	film, 1470 ohms, ±1%, 1/4 w
11R17		90496-139	150 ohms, ±5%, 1 w
11R18		82283-178	6200 ohms, ±5%, ½ w
11R19, 11R20		82283-163	1500 ohms, ±5%, ½ w
11R21	221923	990724-305	film, 1100 ohms, ±1%, 1/8 w
11R22	213701	990724-389	film, 8250 ohms, ±1%, 1/8 w
11R23	221919	867970-9	wire wound, 0.51 ohms, ±5%, ½ w
11R24		82283-111	10 ohms, ±5%, ½ w
11R25		82283-131	68 ohms, ±5%, ½ w
11S1	221273	8511366-1	Switch: push-button, S.P.D.T.
11T1	221271	8449544-1	Transformer: power, 115 v 60 cps
11XF1 to 11XF3	97912	8813054-1	Holder: fuse
			Miscellaneous:
	18469	85558-3	Plate: capacitor mounting, for 11C1 and 11C2
	28452	85558-2	Plate: capacitor mounting, for 11C3
POWER 2 UNIT, 8511325-501			
12J1	221268	8414862-4	Connector: male, 24 contacts
12R1, 12R2		82283-159	Resistor: fixed, comp., 1000 ohms, ±5%, ½ w
12TP1, 12TP2	214603	8941099-5	Jack: tip, yellow
12XQ2	219949	8975560-2	Socket: transistor

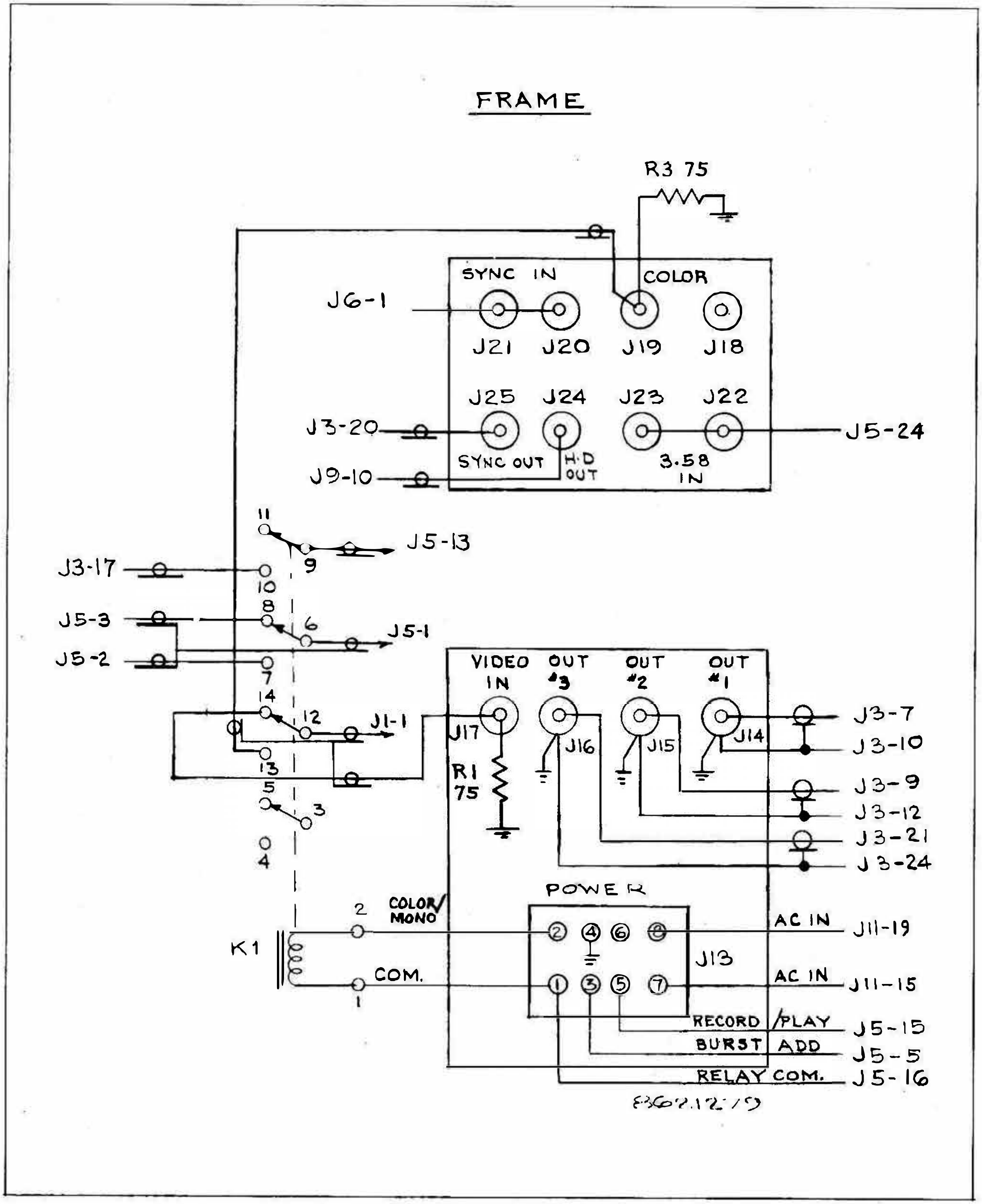
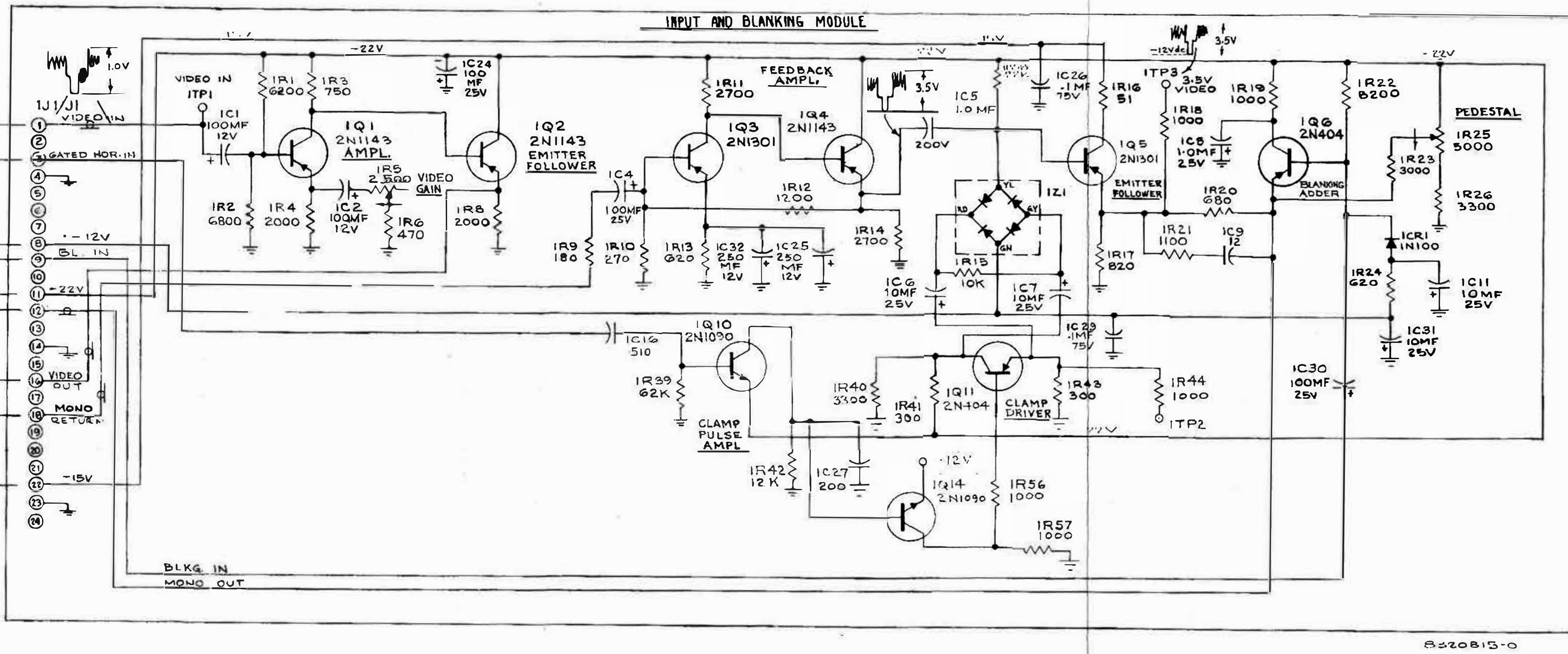


Figure SPA-45. Schematic Diagram of Signal Processing Amplifier Frame

SPA-68



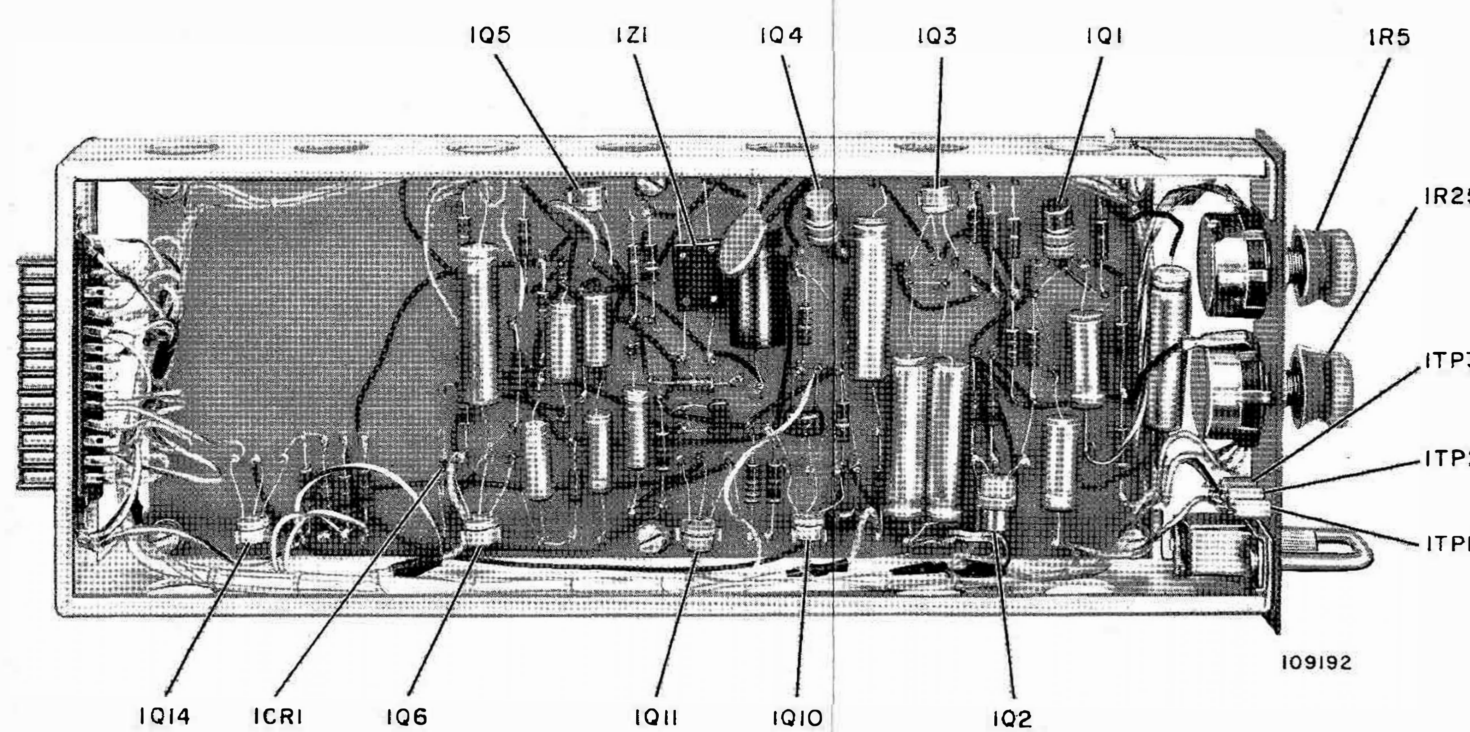
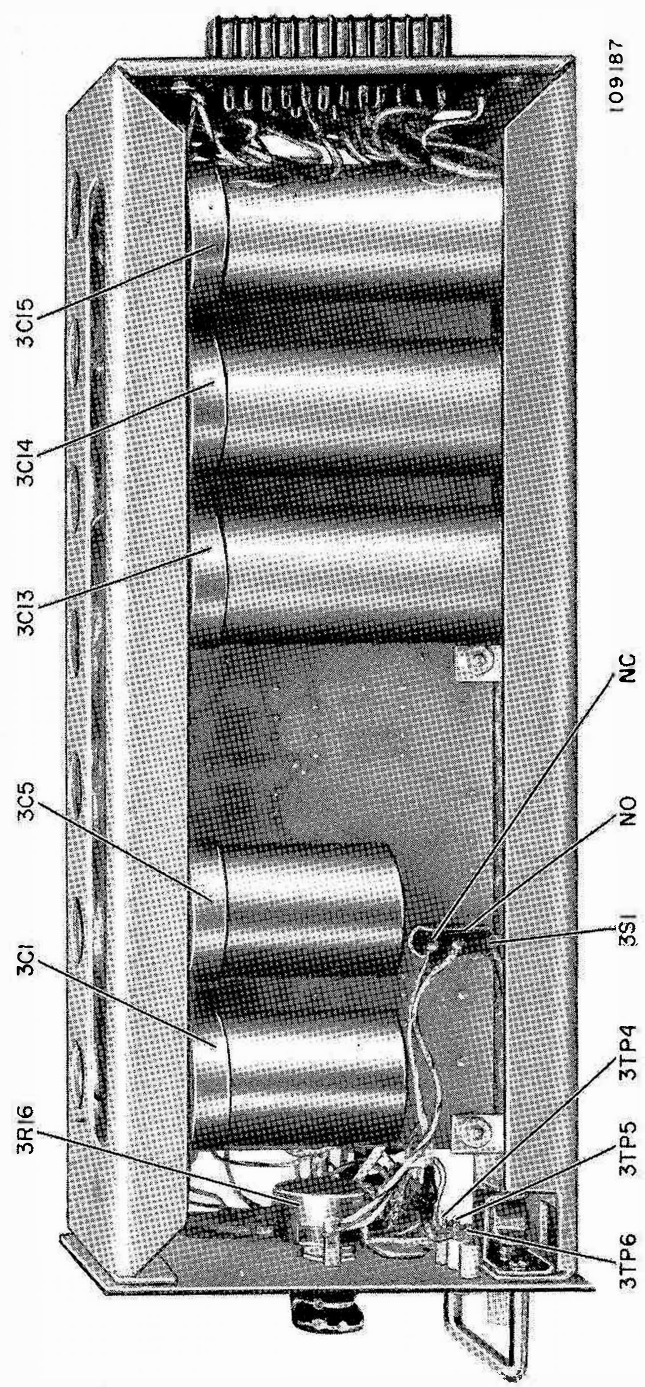
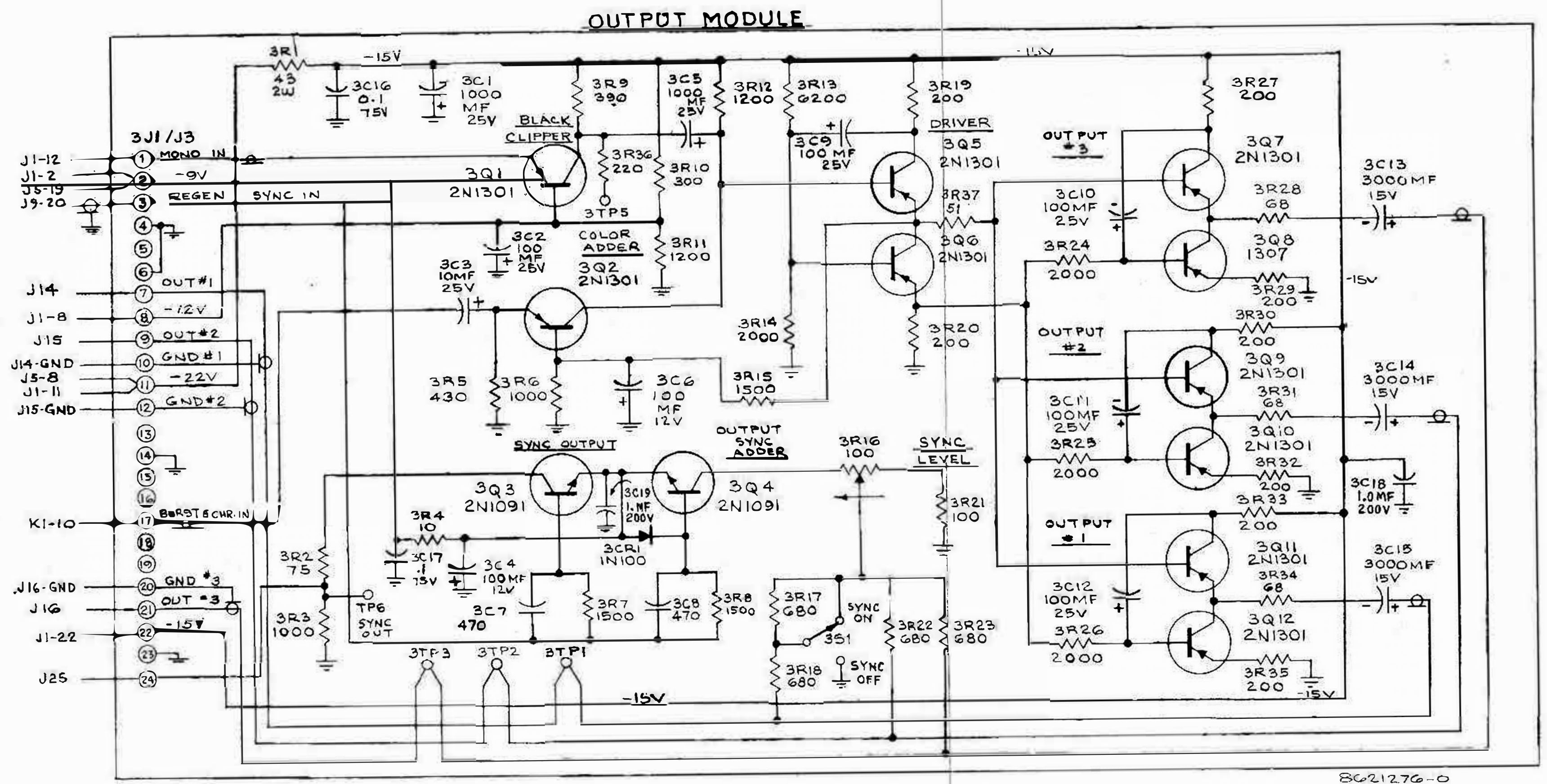


Figure SPA-46. Schematic Diagram with Chassis View of Input and Blanking Module





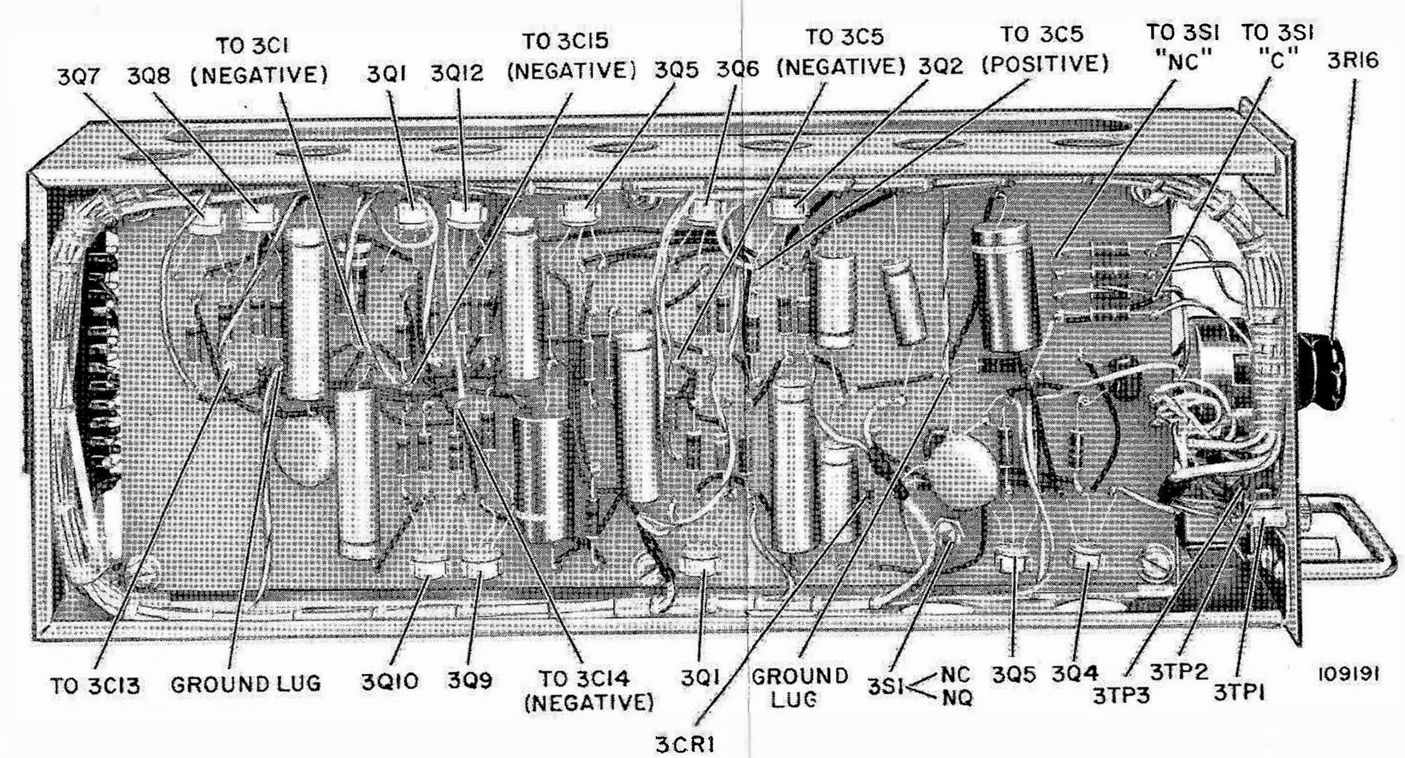
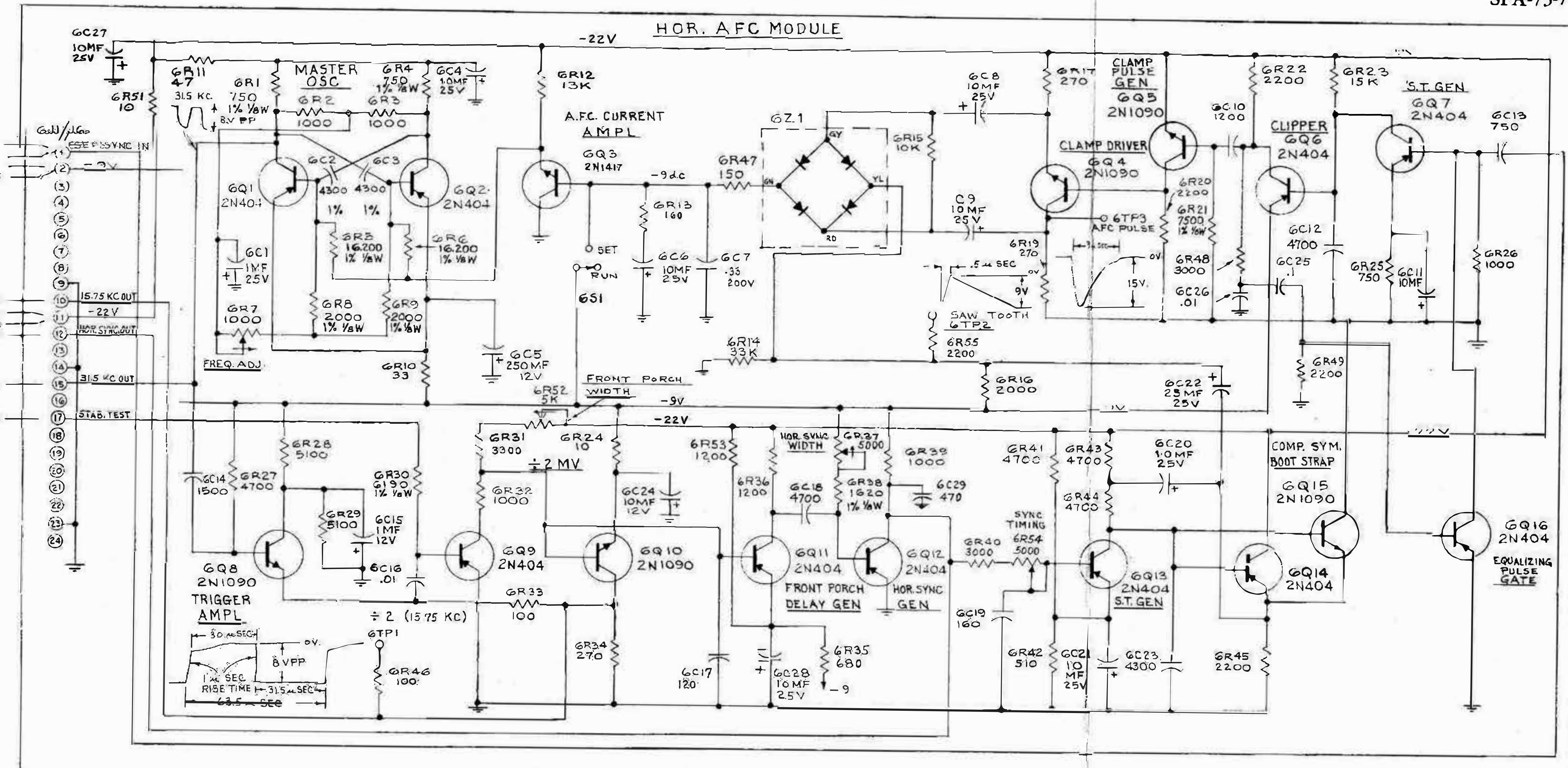


Figure SPA-47. Schematic Diagram with Chassis Views of Output Module



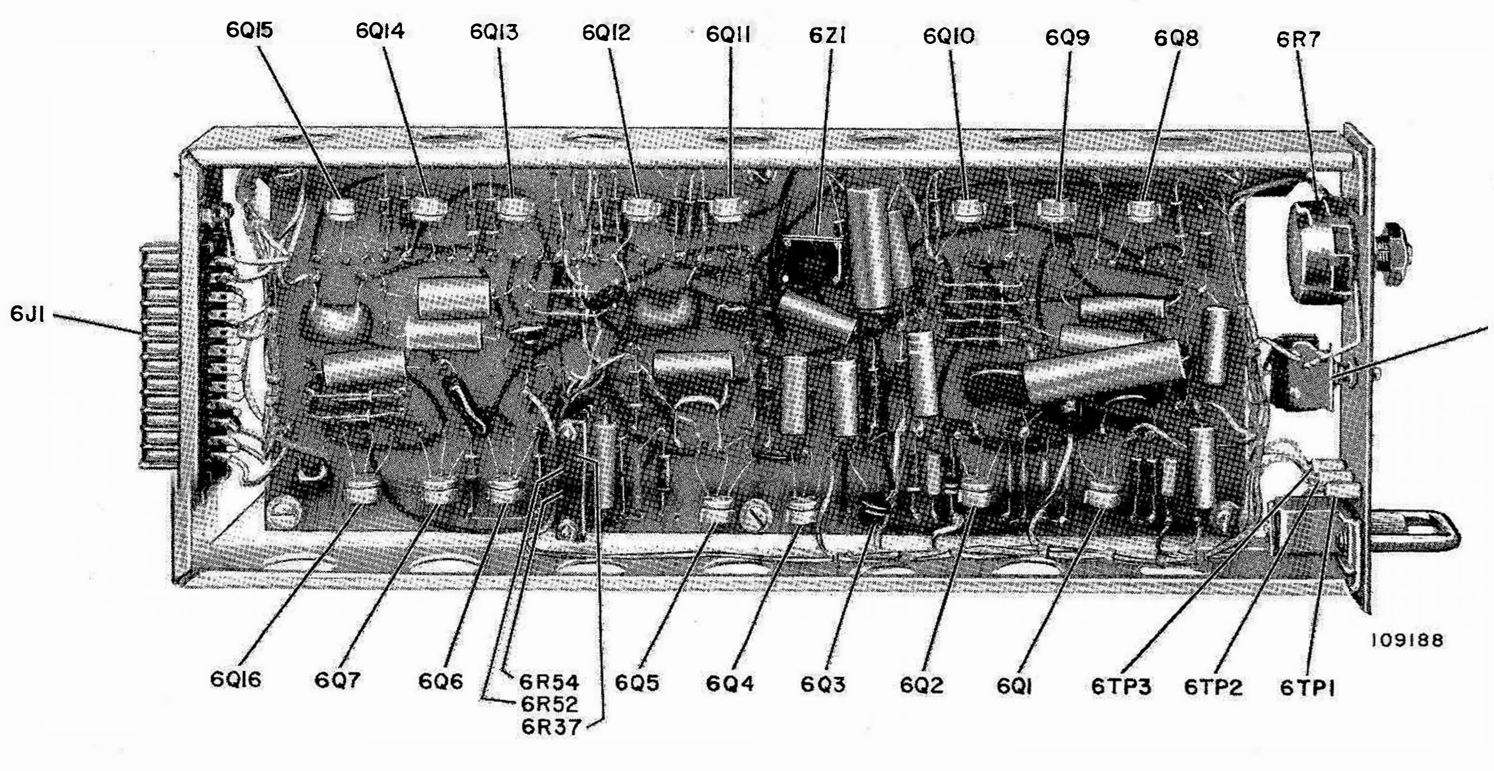
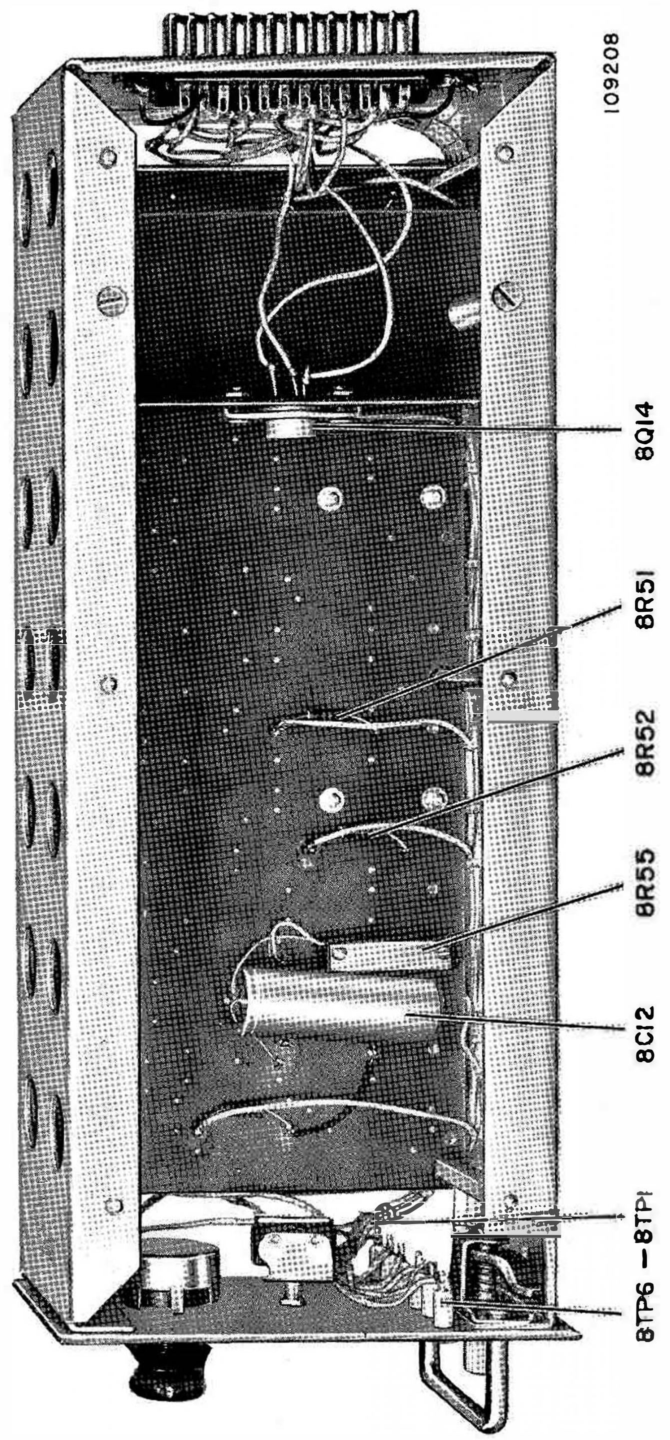
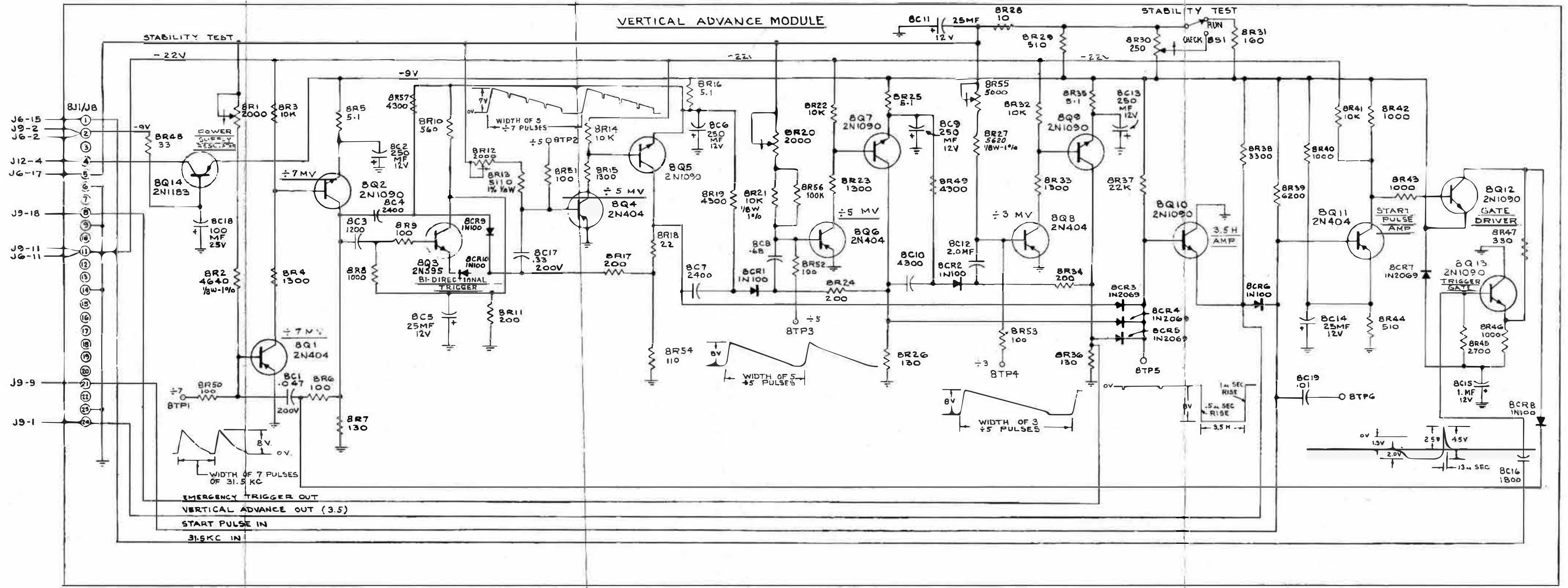


Figure SPA-48. Schematic Diagram with Chassis View of Horizontal AFC Module





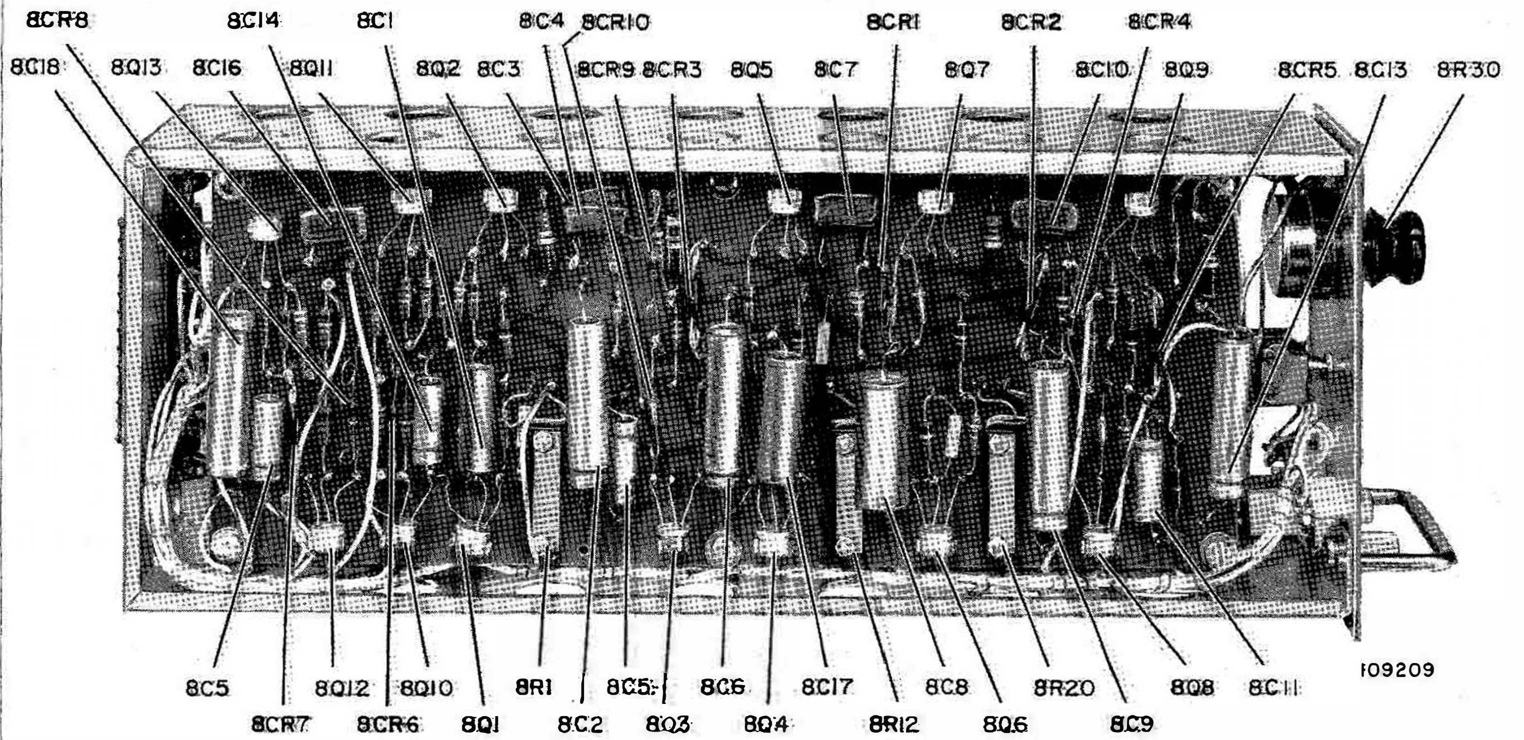
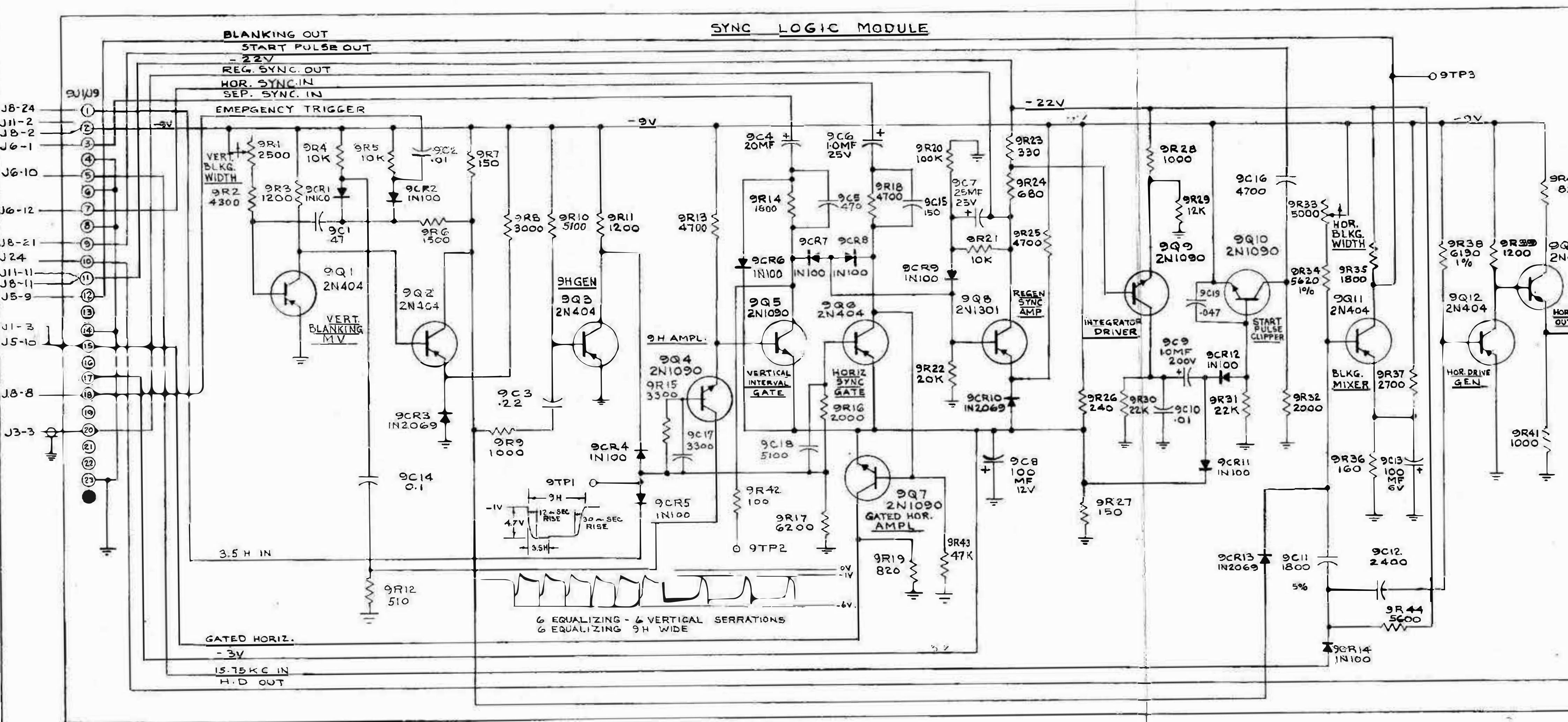


Figure SPA-49. Schematic Diagram with Chassis Views of Vertical Advance Module



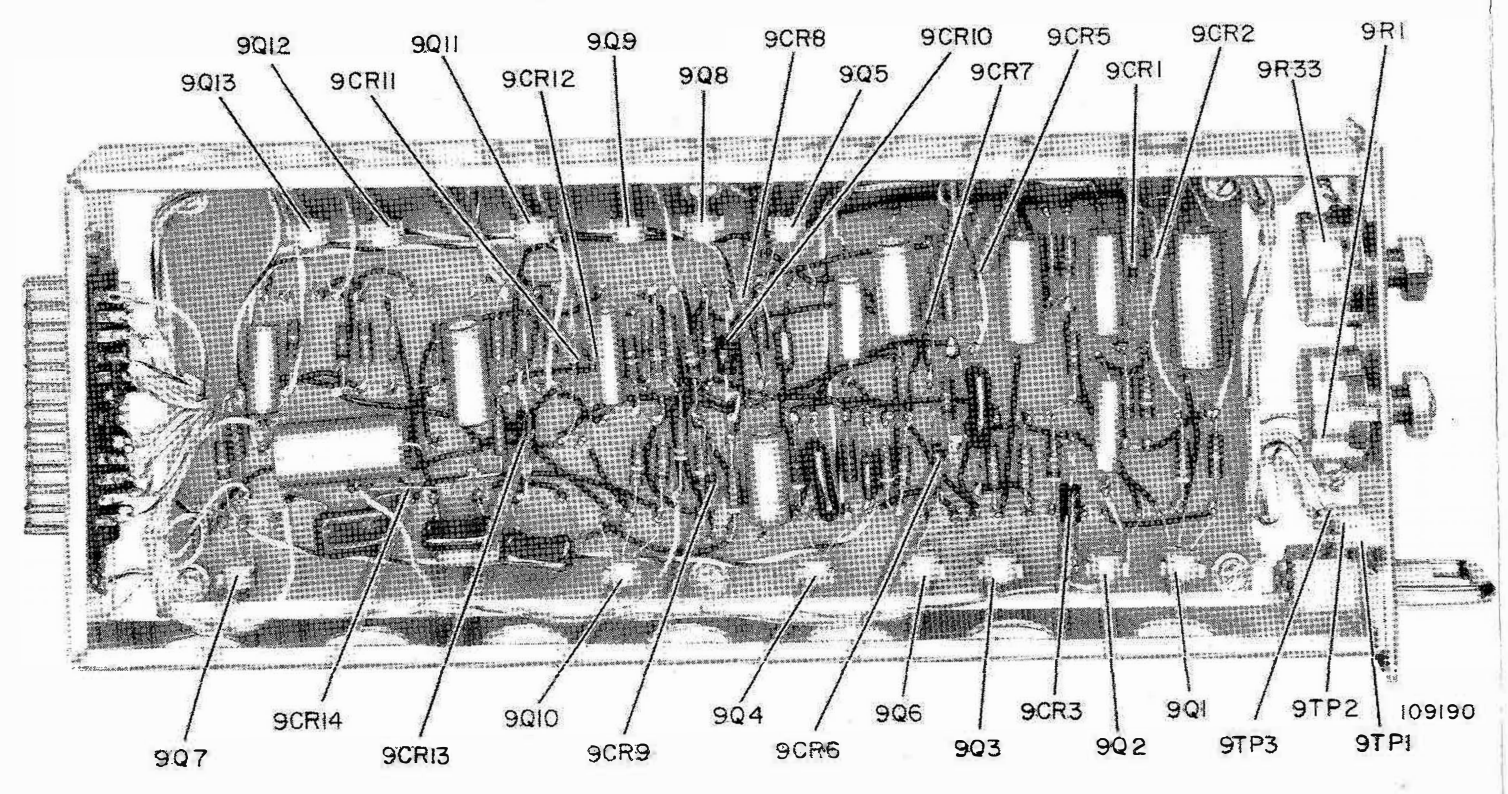
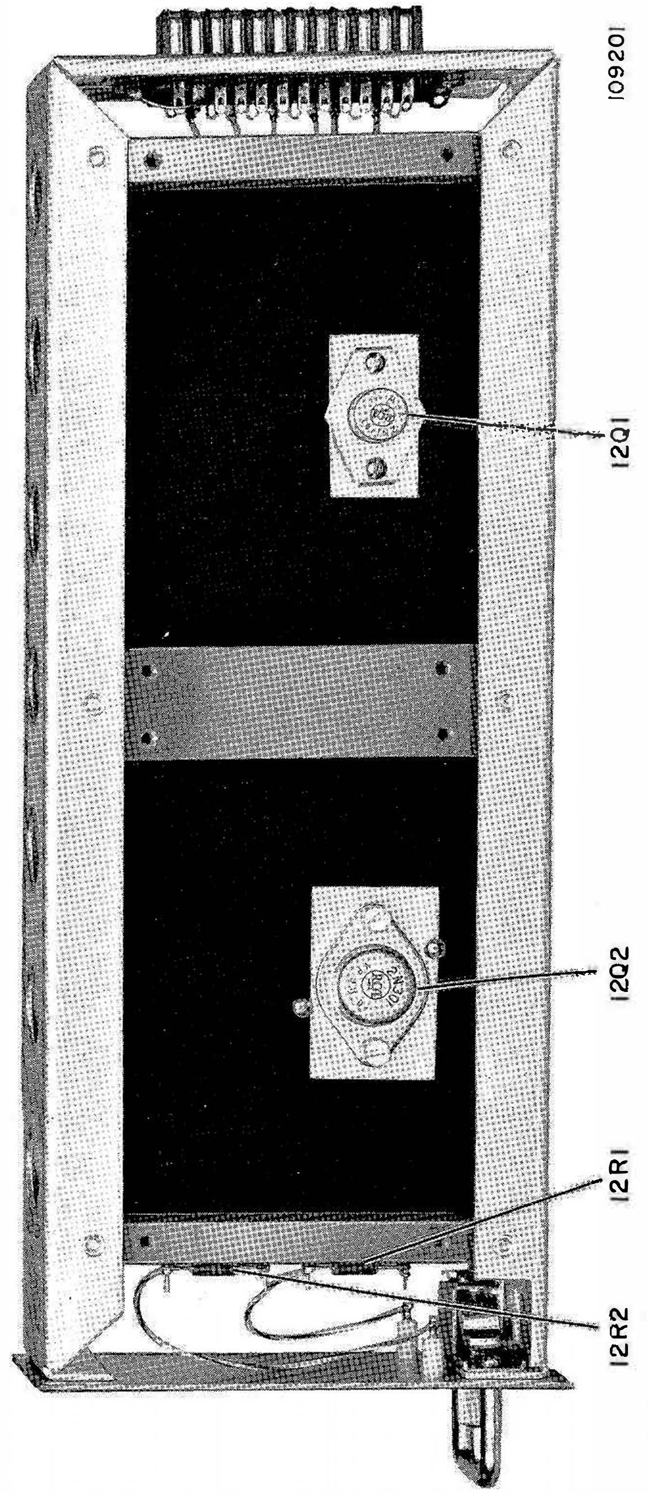
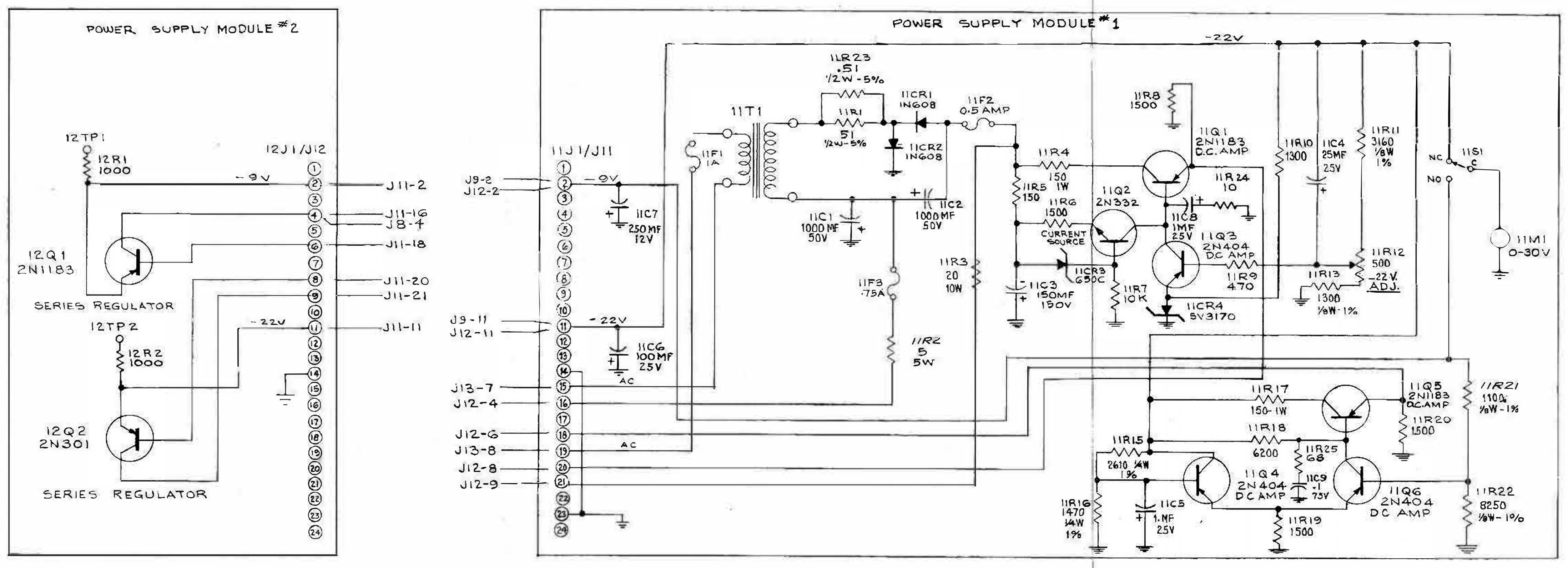
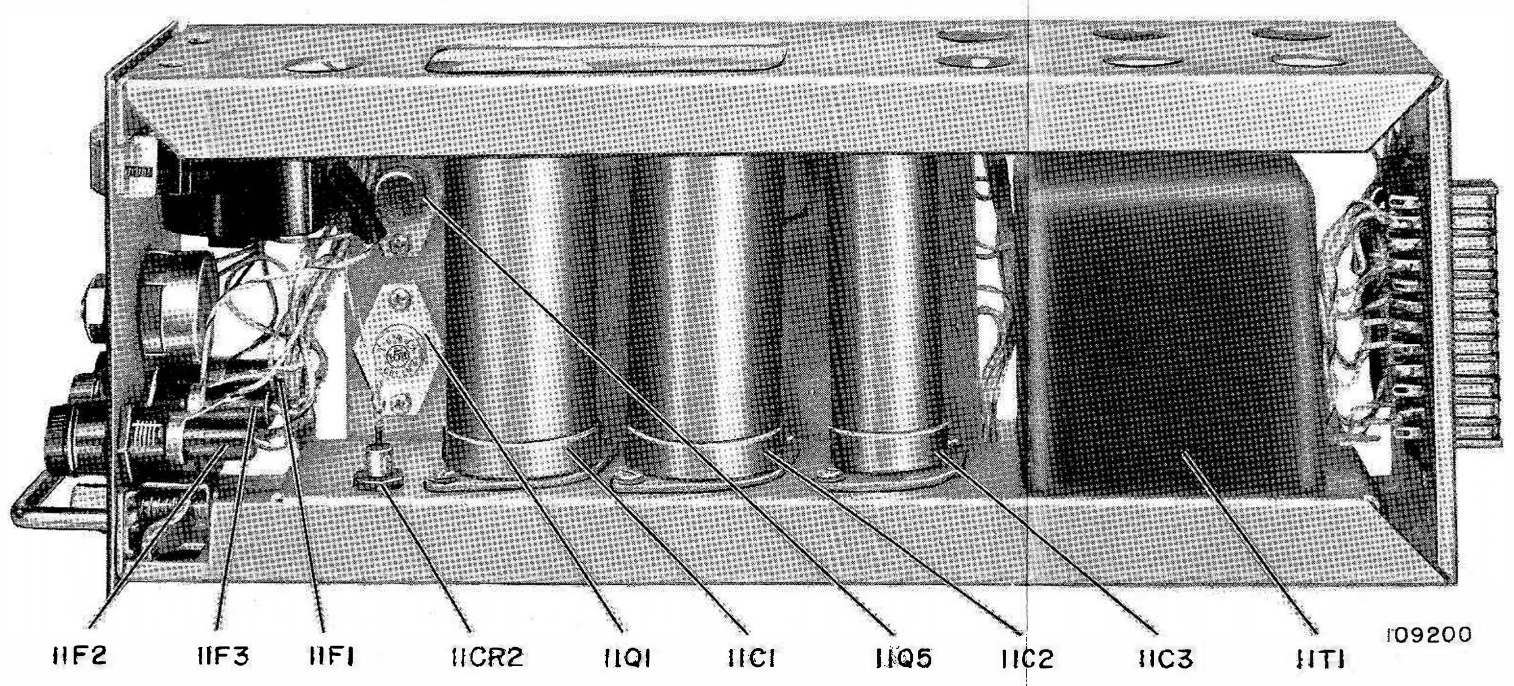


Figure SPA-50. Schematic Diagram with Chassis View of Sync Logic Module.

Figure SPA-51. Schematic Diagram with Chassis Views of Color Module







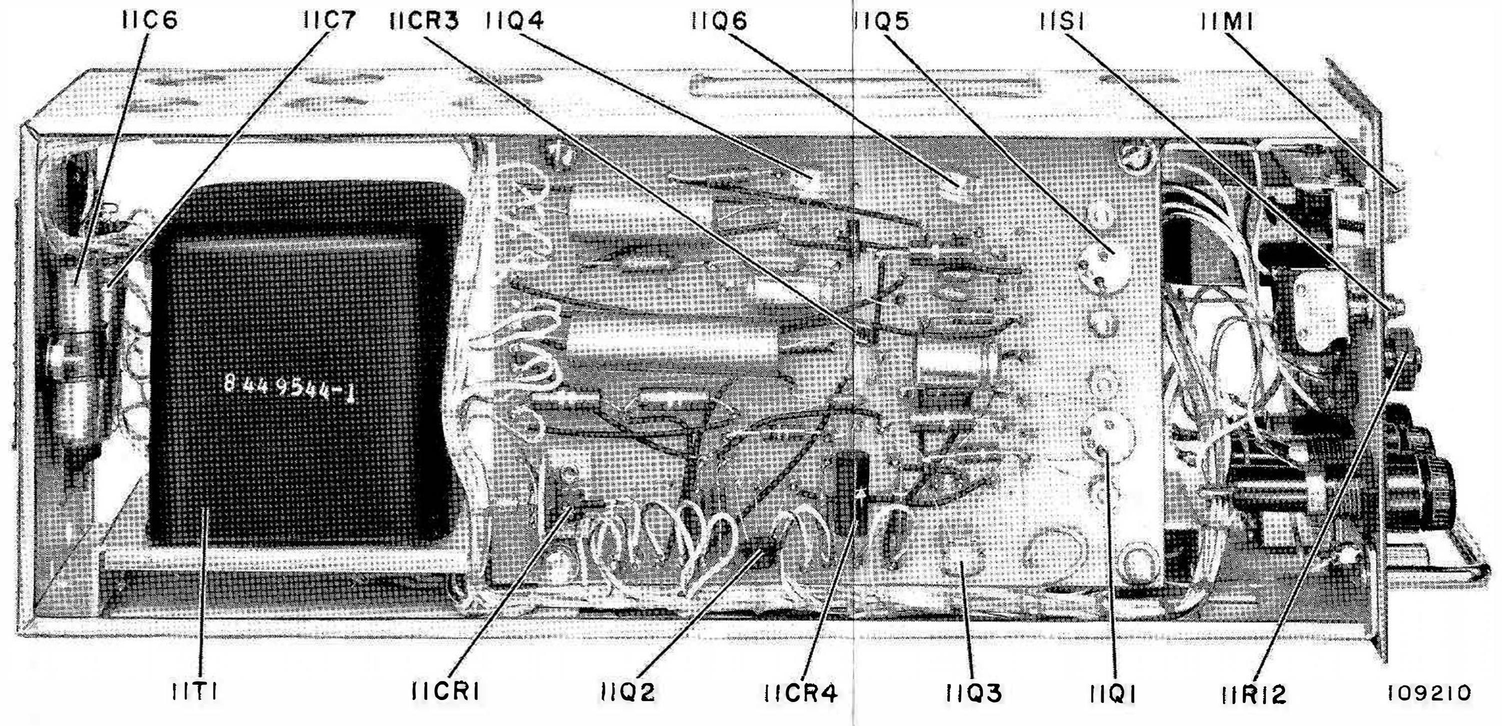


Figure SPA-52. Schematic Diagram with Chassis Views of Power 1 and Power 2 Modules

ELECTRONIC RECORDING PRODUCTS

2 x 1 Switcher

UNIT 309

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31146

PRINTED IN U.S.A.
WA 681

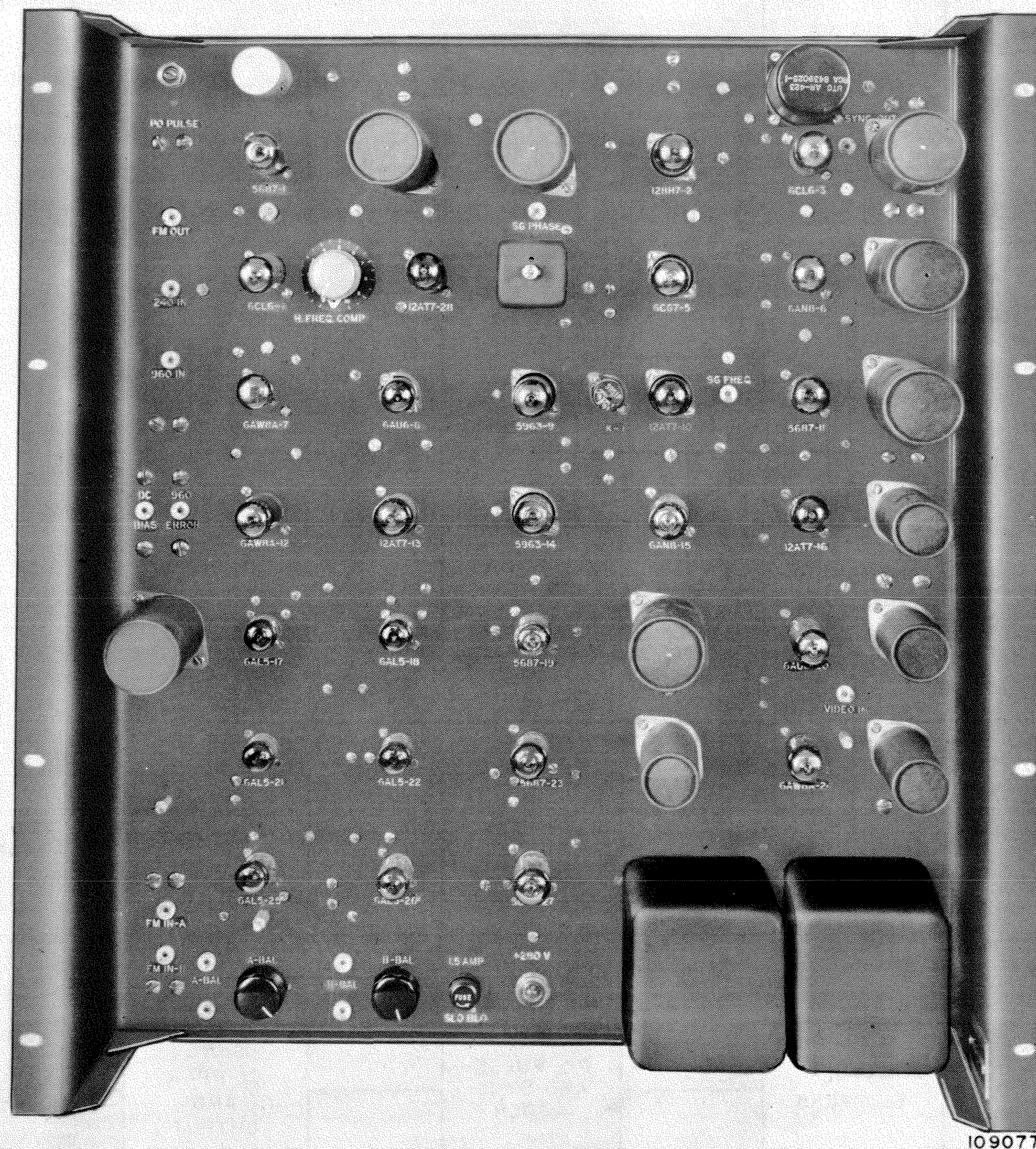


Figure S-1. 2 x 1 Switcher, Front View

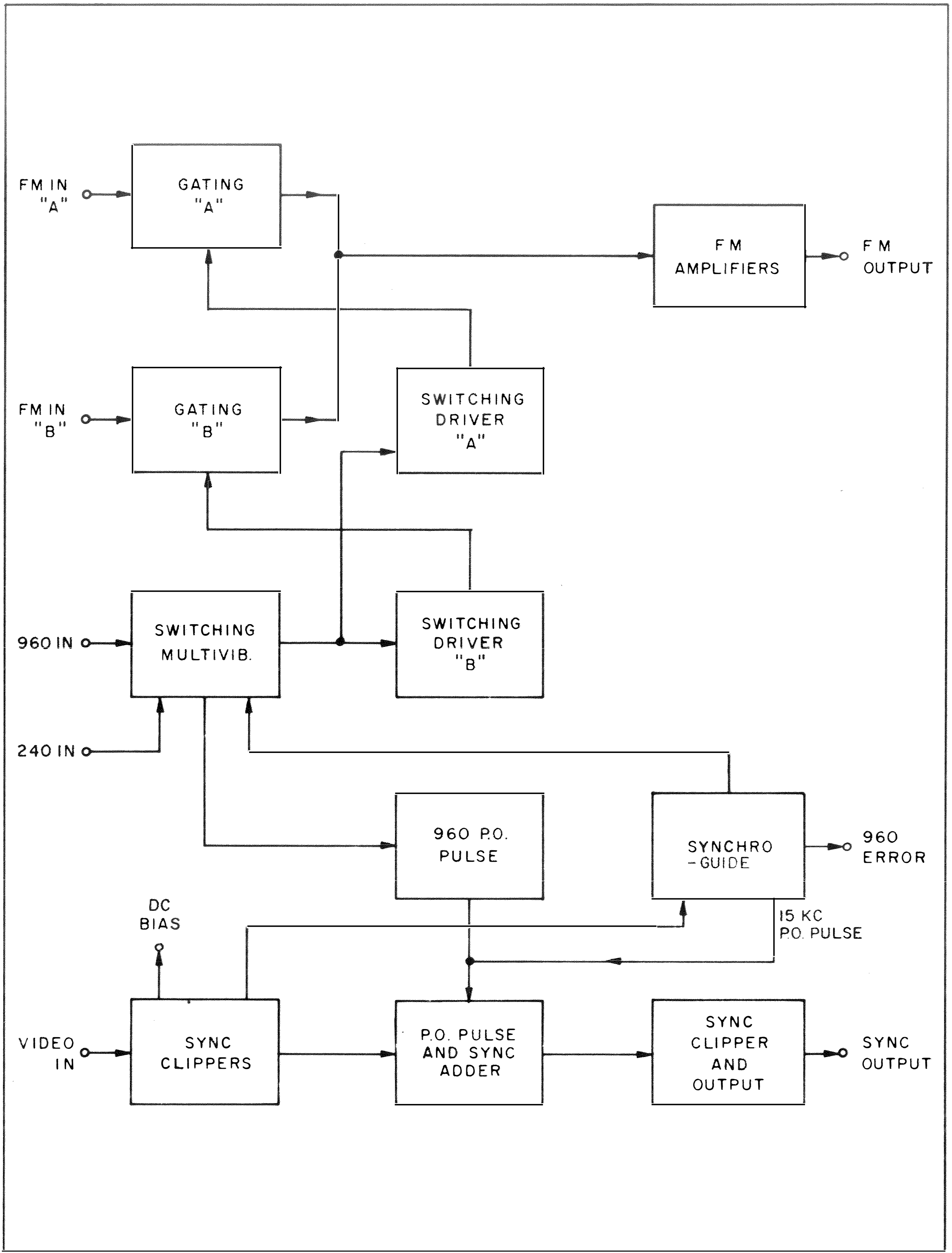


Figure S-2. Simplified Block Diagram of 2 x 1 Switcher

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cps, 100 watts
(from circuit breaker no. 2).

DC: 280 volts, 375 ma
(from power supply no. 2, unit 410).

Inputs

FM signals "A" and "B":
0.5 volt peak-to-peak (from 4 x 2 switcher, unit 207).

960 cycle pulse:
4.0 volts peak-to-peak, approximately
(from tonewheel amplifier, unit 505).

240 cycle pulse:
4.0 volts peak-to-peak
(from tonewheel amplifier, unit 505).

Video:
1.0 volt peak-to-peak, nominal
(from demodulator, unit 201).

Error Signal Supplied to Guide Servo

75 millivolts peak-to-peak (at 960 cps) per mil error in guide position.

DC Bias Supplied to Guide Servo

—6 volts dc, nominal.

Frequency Compensation

Variable (see figure S-8).

Outputs

Combined FM signal:
1.0 volt peak-to-peak, nominal
(to demodulator, unit 201).

Separated Sync:
4.0 volts peak-to-peak
(to processing amplifier, unit 308).

Fuse

1.5 amperes, slo-blo, 3AG

Tube and Diode Complement

Tubes:	6 — 6AL5
	5 — 5687
	4 — 12AT7
	3 — 6AW8A
	2 — 6CL6
	2 — 5963
	2 — 6AN8
	1 — 6AU6
	1 — 6CG7
	1 — 6AU8
	1 — 12BH7
Diodes:	4 — 1N54A
	2 — 1N2071

DESCRIPTION

The 2 x 1 switcher (unit 309) is shown in figure S-1. The separate functions of the unit are described briefly below, and in greater detail in the section on circuits. (Refer to the simplified block diagram, figure S-2.)

1. A function of the unit is to combine two fm inputs ("A" and "B") from the 4 x 2 switcher (unit 207) into a single output which is fed to the demodulator (unit 201). In combining the fm signals, switching is controlled so that the head signals are maintained in proper sequence (1, 2, 3, 4, etc.).

2. The video signal from the demodulator is fed back to the 2 x 1 switcher so that the sync pulses may be separated from the video. The separated sync pulses are used for a number of timing operations, including the control of the 2 x 1 switching function. Circuits are provided to remove switching transients from the separated sync pulses.

3. A 960-cycle error signal is developed by an adaptation of the synchroguide circuit. This signal is fed to the guide servo (unit 506) to automatically adjust the guide position so that the correct position may be maintained.

4. The unit also generates a dc bias voltage which is fed to the guide servo chassis so that the servo may operate automatically. When the video signal from the demodulator disappears or drops well below its normal level the bias voltage is removed, thus placing the guide servo in manual operation.

Circuits

Sync Separation. As shown on the block diagram, figure S-3, and schematic diagram, figure S-20, the composite video signal from the demodulator, having an amplitude of one volt peak-to-peak, is fed to the 2 x 1 switcher at input jack J10 and may be observed at test point TP6 (VIDEO IN). Video amplifier V24A raises the composite signal amplitude to approximately 46 volts peak-to-peak before it is fed to cathode follower V24B which provides a low input impedance to the following stage (V20A).

V20A is operated with no cathode bias, so that the high-level composite signal applied to its grid easily drives the tube below cutoff, thus removing the video portion of the signal while retaining sync. The positive-going sync pulses cause grid current to flow, thereby charging coupling capacitor C20 and causing the sync tips to line up at a uniform dc level. This results in clipping level stabilization.

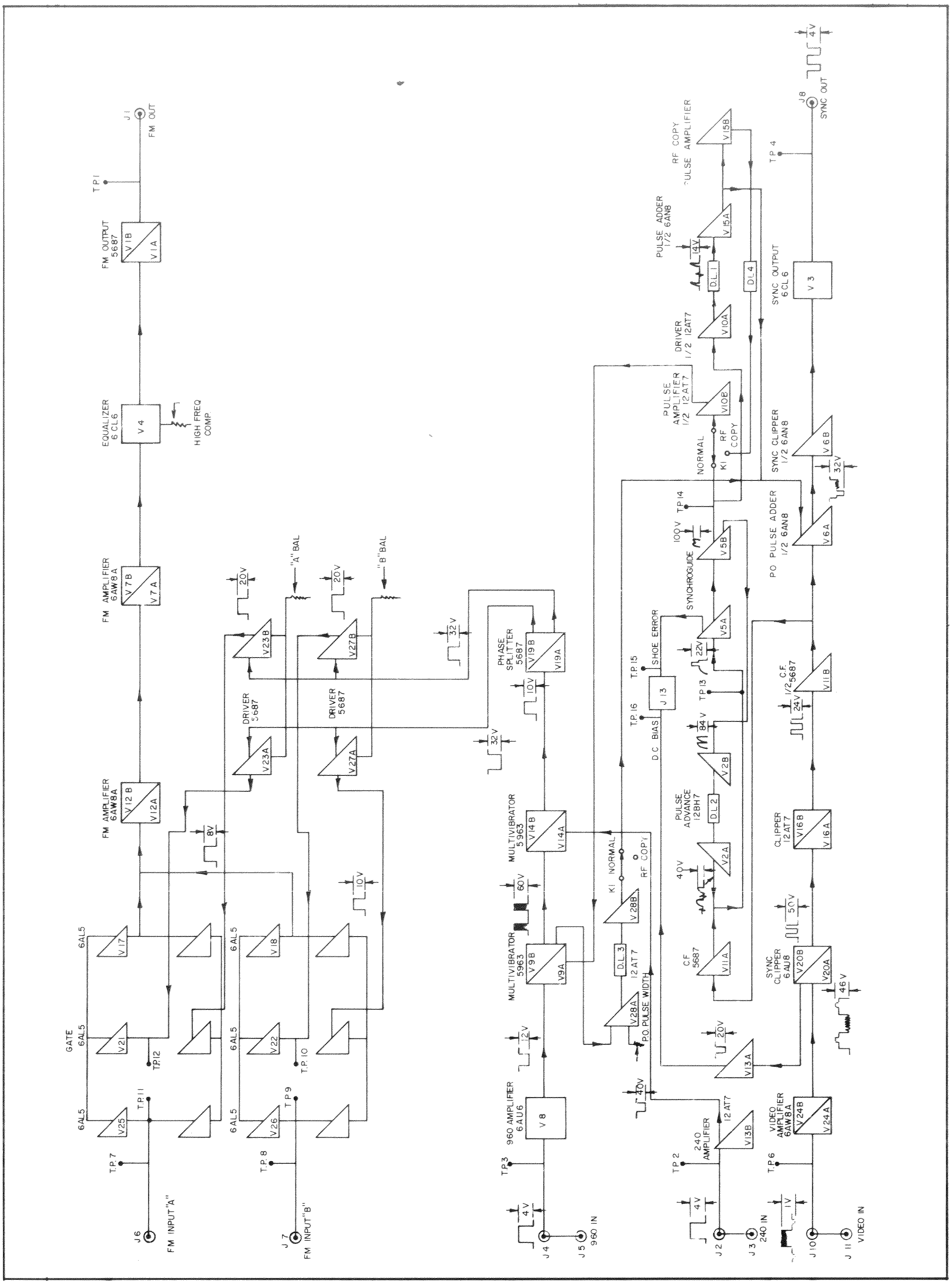


Figure S-3. 2 x 1 Switcher, Block Diagram

The amplitude of separated sync is increased to approximately 50 volts peak-to-peak by pulse amplifier V20B before it is fed to sync clipper V16. The purpose of V16 is to provide pulses of constant amplitude even when the input video signal amplitude varies over an appreciable range. Diode CR2 sets the dc level of the positive-going sync pulses applied to the grid of V16A within the conduction range of the tube. The input pulses drive the grid of V16A below cutoff and the clipped waveform is fed directly to the cathode of V16B. The separated sync then appears in the plate circuit of V16B as a positive-going pulse with an amplitude of approximately 24 volts peak-to-peak.

Cathode follower V11B provides a low impedance input to sync adder V6A and cathode follower V11A. The positive-going sync pulses fed to the grid of sync adder V6A are inverted and added to pushout pulses from V15A and V28 in the plate circuit of V6A.

Pushout pulses are required to remove switching transients which occur during the first half of every 16th or 17th horizontal sync pulse. The switching transients are removed by pushing them outside the normal amplitude range of sync and clipping them off in sync clipper stage V6B. Two pushout pulses are used in this operation. One pulse is derived from the trigger source for the fm switching circuit and occurs only at the time an actual video head switch takes place (nominally 960 cps). The width of this pulse must be adjusted so that it is only slightly narrower than the horizontal sync pulse width, and it must also be delayed to compensate for delays in the demodulator and sync separator circuits. The second pushout pulse, derived from the synchroguide circuit, is narrow enough to fall within the equalizing pulse interval and recurs at a 15.75 kc rate. This pulse must be delayed to compensate for the pulse advance in the synchroguide circuit (see *Synchroguide*). The primary function of this pulse is to insure removal of switching transients recorded in rf copies which may not coincide with switching transients in the final playback machine.

The signal applied to the grid of sync clipper V6B contains sync pulses, pushout pulses, and switching transients. The amplitude of this signal is great enough to cause the pushout pulses and switching transients to fall below the tube cutoff level, thus allowing only sync pulses to appear at the plate of V6B. These sync pulses are amplified by sync output stage V3 and appear at output jack J8 as negative-going pulses having amplitudes of 4 volts peak-to-peak. The separated sync output may be observed at test point TP4 (SYNC OUT) before it is fed to the processing amplifier (unit 308) and reference generator (unit 407). (Where color processing equipment is used, separated sync is also fed to the burst oscillator, unit 605).

FM Switching. The fm input voltages from the 4 x 2 switcher consist of fm head signals 1 and 3 combined into fm input A, and fm head signals 2 and 4 combined into fm input B. A function of the 2 x 1 switcher is to combine the two individual inputs into a single output with the fm head signals maintained in the proper sequence (1, 2, 3, 4, etc.). A 960-cycle tonewheel pulse is used to trigger the gate circuits which control the switching of fm signals A and B so that this sequence may be maintained. Initial correct phasing of the sequence is obtained from a 240-cycle tonewheel reference pulse.

A three TV line overlap occurs in the transverse track signals so that before head no. 1 leaves the tape, head no. 2 has entered and is reading the same information as head no. 1. Similarly, there is an overlap between video heads 2 and 3, 3 and 4, 4 and 1. Switching between signals A and B is desired during the first horizontal sync pulse which occurs during this overlap interval.

The 960-cycle pulse which identifies the overlap interval is obtained from the tonewheel amplifier (unit 505), and is applied to the 2 x 1 switcher at jack J4. The pulse, having a nominal amplitude of 4 volts peak-to-peak, is fed to amplifier V8 and may be observed at test point TP3 (960 IN). Following amplification to approximately 12 volts peak-to-peak by V8, the pulse is fed directly to the left side of bi-stable multivibrator V9. This side of V9 is then cut off, allowing the right side to conduct. Because of the dc networks connecting the plate of one side of V9 to the grid of the other side and vice versa, the right side mentioned above will continue to conduct until it is triggered by a pulse derived from the synchroguide circuit (see *Synchroguide*). Capacitors C64 and C66 bypass high frequency energy around the dc networks so that the "flipping" action of V9 will be accelerated.

The first synchroguide pulse applied to V9 following a 960-cycle pulse flips the multivibrator until the next 960-cycle pulse appears. Because the synchroguide pulses appear much more frequently than the 960-cycle pulses (15.75 kc as compared with 960 cps), the right side of V9 is cut off and the left side is conducting most of the time. This action results in a narrow (90 to 150 microsecond wide) pulse output from the left side of V9 which occurs at an average 960-cycle rate. The 960-cycle frequency is an average rate due to the fact that its period may vary between 16 and 17 lines, depending upon the phase of the 960-cycle pulse with

respect to sync. Because the synchroguide pulse is locked to incoming sync, the trigger pulse occurs only during the horizontal sync period—thus preventing switching transients from appearing in the video information.

The 960-cycle pulse output of V9 is differentiated by the network consisting of capacitor C63 and resistor R159, producing a positive pip and a negative pip. The positive pip is shorted to ground by diode CR8 so that only the negative pip, corresponding to the transition of V9 from the left side cut off to the left side conducting, is used to trigger bi-stable multivibrator V14.

The trigger pulses are fed simultaneously to both sides of V14 through diodes CR6 and CR7. This causes the circuit to act as a binary divider since each trigger pulse reverses the conduction state of V14 by cutting off whichever side was conducting. Although the trigger pulses occur at a 960-cycle rate, each side of V14 conducts only 480 times per second. Thus, the output of V14 is a 480-cycle pulse which is not quite a square-wave because the starting times for successive half cycles are altered slightly by the gating action of V9.

A 240-cycle tonewheel pulse, applied to the unit at jack J2 and amplified by V13B is fed to the right-hand side of V14. (Test point TP2 (240 IN) is provided as a convenient point to observe the pulse.) The purpose of this pulse is to make certain the right-hand side of V14 is cut off during the time video head no. 1 is putting out a signal, so that the fm gates operate in the correct phase. This is important because incorrect phase operation of the fm gates causes them to deliver mostly noise signals. Normally, the 240-cycle pulse circuit is operative only during the start-up period or immediately following a severe discontinuity in the tape signal (e.g. a bad splice).

The 480-cycle pulse output of V14 is applied to one grid of cathode-coupled phase-splitter V19. Load resistors R140 and R146, in the plate circuits of V19, are slightly unequal to compensate for a small level loss due to the cathode coupling. The output pulses of V19, equal in amplitude and opposite in polarity, are fed to switching drivers "A" and "B" (V23 and V27). These tubes are used as cathode followers which provide low impedance inputs to the diode gating circuits. Potentiometers R3 (A-BAL) and R83 (B-BAL) are adjusted to set the dc voltage levels for minimum gating transients in the final fm output signal (see *Maintenance*).

Switching drivers A and B provide switching signals which control two fm gating circuits, each circuit containing three 6AL5 double-diodes (V25, V21, V17, and V26, V22, V18). The gating diodes (V21 and V22) of each gating circuit simultaneously receive switching signals of opposite polarity from the switching drivers which allow them to conduct or cut them off, according to the signal polarity, thereby causing the gating diodes to control the switching diodes of their respective gates.

The operation of gating circuit A may be seen by considering the period during which one half of gating diode V21 receives a positive switching signal at its cathode (pin 1), while the other half receives a negative signal at its plate (pin 2). In this condition the bias voltage on V21 is such that the tube is cut off. Switching diodes V25 and V17, connected in parallel, form a voltage divider network in conjunction with resistors R2 and R4, and because of the fixed voltages applied to their plates and cathodes these diodes conduct during the time that gating diode V21 is cut off. When the switching diodes are conducting, they provide a low impedance path for fm input A to the fm amplifier circuit.

A reversal of polarity of the switching signals will change the bias voltage on gating diode V21 so that it will be in a conducting state. This in turn alters the voltage distribution of the voltage divider network so that switching diodes V25 and V17 receive a reverse bias voltage which cuts them off, thus preventing the passage of fm signal A to the amplifier circuit.

Gating circuit B operates in a manner identical to that of gating circuit A. However, the phase of switching signals applied to gating diode V22 is opposite to that of the signals applied to gating diode V21, thereby causing gating circuit B to close when gating circuit A opens and vice versa. FM signals A and B are thus combined into a single fm output signal which is fed to the fm amplification circuit.

The combined fm signal is amplified by wide-band amplifiers V12B and V7B which are stabilized by cathode degeneration. Cathode followers V21A and V7A are used to furnish high impedance loads to the stages preceding them, thus minimizing the loading effects on these stages. The amplified fm signal is fed to equalizer stage V4 which operates for all head channels simultaneously, supplementing the action of the 4 channel equalizer (unit 105) by compensating for the loss of high frequency components of the fm signal in the head-to-tape transfer during record and playback modes. It should be noted that losses in the higher frequency ranges of the fm spectrum are equivalent to losses in the lower frequencies of the video signal or peaking of the higher video frequencies. Potentiometer R177 (H. FREQ. COMP), in the plate circuit of V4, provides a means of adjusting the magnitude of the high frequency compensation (see *Operational Adjustments*). Variable coil L2, also in the plate

circuit of V4, is used as a shunt peaking coil and is normally adjusted for maximum peaking at 9 megacycles (see *Maintenance*).

FM output stage V1 is a totem-pole type amplifier providing some of the characteristics of a push-pull amplifier while driving a single-ended output signal. The two sections of V1 are driven by signals in phase opposition, so that any curvature in the tube characteristics tends to cancel out. Output impedance matching is obtained through the use of 22 ohm resistor R31. The combined fm output signal is fed from jack J1 (FM OUT) to the demodulator and may be observed at test point TP1 (FM OUT).

Synchroguide. The synchroguide circuit is a form of automatic frequency control having excellent stability and noise immunity. The purpose of this circuit is to provide pulses for use in the fm switching and sync separation sections of the unit, and to develop the guide error signal.

Blocking oscillator V5B, having a "flywheel" time constant somewhat greater than the 16-line head scanning interval, free-runs at approximately line frequency (15.75 kc). Autotransformer T3 provides a positive feedback voltage from the plate of V5B to its grid. The feedback voltage continues to increase until the tube reaches saturation, at which point a very rapid decrease in current takes place and the grid voltage is driven well below the cutoff level. The stage remains cut off until the grid voltage rises above the cutoff level at a rate determined by the time constant of the RC network in its grid circuit. Transformer T3 is tuned, in conjunction with capacitor C88, to obtain the required phase and frequency relationships between the waveform generated by the synchroguide circuit and sync pulses applied to the circuit from cathode follower V11A so that optimum oscillator stabilization is effected (see *Maintenance*). It should be noted that V5B is not triggered directly, but is controlled by a relatively slow acting AFC system so that it cannot be triggered at undesired intervals by spurious noise signals.

The plate output signal from V5B is integrated by the network consisting of resistor R216 and capacitor C90, and fed to pulse advance stage V2B as a distorted sawtooth waveform. Delay line DL2, in the cathode circuit of V2B, delays the sawtooth signal 1.75 microseconds before it is fed to cathode follower V2A. Separated sync pulses are fed from V11B in the sync separator section of the unit to V11A and are then combined with the delayed sawtooth signals in the grid circuit of V5A. The net effect of delay line DL2 then, is to advance separated sync 1.75 microseconds with respect to the sawtooth waveform developed in the plate circuit of V5B. (The sync pulse advance is actually required to compensate for sync pulse delay occurring in the demodulator and in the sync separation section so that fm switching will occur near the front edge of sync during the horizontal sync interval.) Both V2A and V2B are operated as cathode followers for isolation and impedance matching at either end of DL2. V11A is a current-stabilized cathode follower used to isolate the synchroguide circuit from the sync separation section.

Control tube V5A operates as a specialized form of phase detector whose purpose is to provide an automatic frequency control for oscillator V5B. A negative bias voltage applied to the grid of V5A allows the tube to conduct only during the time a sync pulse, superimposed upon the sawtooth waveform, appears at the grid. Normally, the first 25 to 30% of each horizontal sync pulse rides near the peak of the sawtooth, while the balance of the pulse drops down on the sawtooth slope so that it falls below the cutoff level of V5A. As the sync pulse shifts up or down on the peak of the sawtooth signal, a variation occurs in the magnitude of plate current flowing in V5A. The varying plate current causes a voltage variation in the cathode circuit of V5A, which in turn appears at the grid of V5B as a change in bias voltage. This alteration of bias voltage automatically adjusts the oscillator frequency so that the sync pulses will "lock" in proper position at the peak of the sawtooth waveform. An RC filter network in the cathode circuit of V5A smooths out the pulses so that the bias voltage applied to V5B is relatively steady. It may be noted that the time constant of the filter network is long enough to change the bias voltage only on the basis of control information integrated over a period of several milliseconds.

Synchroguide pulses occurring at approximately line frequency (15.75 kc) appear in the cathode circuit of oscillator V5B and are fed to pin 3 of relay K1. During normal tape recorder operation (fm switching during horizontal sync), K1 is unenergized and the synchroguide pulse appearing at pin 3 of K1 is fed directly to the grid of pulse amplifier stage V10B. The pulse is amplified by V10B and fed as a trigger pulse to bistable multivibrator V9 (see *FM Switching*).

During monochrome rf copy operation of the tape recorder, fm switching is desired during the back-porch interval of horizontal blanking. In order to time the synchroguide pulse so that switching multivibrator V9 is triggered at the correct instant, relay K1 is energized thus preventing the synchroguide pulse from being fed directly to pulse amplifier V10B and allowing it to be delayed 3.6 microseconds by delay line DL4. Before reaching DL4 however, the pulse is first coupled from

oscillator V5B to the cathode of pulse driver stage V10A by coupling capacitor C40. Delay line DL1, in the plate circuit of V10A, provides a 1.75 microsecond delay so that the pulse, which has been advanced by pulse advance stage V2B, will be returned to its original position with reference to the video input signal. The delayed pulse is then fed to pulse adder stage V15A and output stage V15B in turn. The amplified pulse output from V15B is delayed 3.6 microseconds by DL4 before being fed to pulse amplifier V10B. Switching multivibrator V9 then receives the amplified pulse which has been sufficiently delayed to trigger V9 at the required instant so that fm switching on rf copies will be accomplished during the back porch interval of sync.

Both pushout pulses used in the sync separation section of the unit to remove fm switching transients are obtained from the synchroguide circuit. One of the pushout pulses occurs at a 15.75 kc rate and appears in the plate circuit of pulse adder stage V15A after receiving a 1.75 microsecond delay from delay line DL1. The other pushout pulse occurs at a 960-cycle rate and is developed by V28 before being added to the 15.75 kc pulse in the plate circuit of V15A.

The 960-cycle pushout pulse is derived from the output of switching multivibrator V9 which is applied to a differentiating network in the grid circuit of V28A. Positive pips resulting from differentiation are clipped off by the grid limiting action of V28A while the negative pips are converted to a series of rectangular pulses by driving the grid of V28A below cutoff. The time constant of the differentiating network may be changed by varying potentiometer R183 so that the width of the rectangular pulse can be adjusted to be slightly narrower than the horizontal sync pulse width (see *Maintenance*). Delay line DL3 delays the rectangular pulse 1.75 microseconds to compensate for the sync pulse advance obtained in pulse advance stage V2. The delayed rectangular pushout pulse is amplified by V28B.

Separated sync, the 15.75 kc pushout pulse, and the 960-cycle pushout pulse are added together in the common plate circuit of V28B, V15A, and V6A. This addition results in pushing the fm switching transients below sync tip level. Sync clipper V6B then removes the transients along with the pushout pulses (see *Sync Separation*). Note that during rf copy monochrome operation relay K1 is energized, thus removing the 960-cycle pushout pulse which is not required in this mode of operation because the early stages of the sync separation section eliminate any switching transients occurring during the back-porch interval of horizontal blanking.

Guide Error Signal. Incorrect guide position will cause slight timing errors in the video output signal. These timing errors appear as discontinuities at the instant of switching from one video head to the next. Although the "flywheel" effect of the synchroguide oscillator produces a series of average frequency pulses, thereby causing line scanning to occur at essentially constant frequency, the timing errors in blanking and all other signal components cause an effect in the television raster known as "jogging", "skew", or the "venetian blind effect".

A "jog" in the raster results in a sync pulse having a varying period appearing at the grid of synchroguide control tube V5A. This variation occurs at a 960-cycle rate, therefore the width of the sync pulse riding on the peak of the sawtooth waveform varies at the same rate. Since the tube conducts only during the time a sync pulse riding on the peak of the sawtooth waveform appears at the grid, its current is proportional to the pulse width and also varies at a 960-cycle rate.

The circuit consisting of coil L3 and capacitor C80, in the plate circuit of V5A, is tuned to 960 cps. The voltage developed across the tuned circuit follows the tube current variation at 960 cps, and is fed to transformer T4 as a guide error signal. The error signal is then fed to the guide servo chassis from jack J13, pins 15 and 16, and may be observed at test point TP15 (960 ERROR).

DC Bias Voltage. A dc bias voltage developed in the cathode circuit of V13A is supplied to the guide servo chassis for automatic control of the guide servo system. Whenever the video signal at the demodulator output disappears, or drops well below its normal level, the bias voltage is no longer present and the guide servo reverts to the manual mode of operation. The manual mode is more reliable in these instances because this mode prevents the servo from being operated by only a noise signal input.

Separated sync pulses from sync clipper stage V20 in the sync separation section of the unit are fed to cathode follower V13A. Negative-going pulses appearing in the cathode circuit of V13A are rectified by diode CR1, and the resultant negative bias voltage is fed to the guide servo from pin 14 of jack J13. Test point TP16 (DC BIAS) is provided as a convenient point to check the bias voltage.

OPERATIONAL ADJUSTMENTS

During the playback mode of operation, the high frequency compensation control (H. FREQ. COMP) must be adjusted because the frequency response of the fm system affects the video frequency response, and because the recording heads and system are factors affecting the fm response. Since the 2 x 1 switcher fm system is in series with the 4 channel equalizer (unit 105), the settings of the high frequency compensation controls of each unit are interdependent. Procedures for obtaining the correct frequency compensation during monochrome or color operation of the machine in the playback mode are given below.

Frequency Compensation for Monochrome and Color Operation

1. Place the machine in playback mode.

2. Set H. FREQ. COMP control on 2 x 1 switcher to mid range (5 on the dial).

3. Press MONITOR DEMOD OUT or MONITOR LINE OUT pushbutton on CRO/MON switcher (unit 307), and observe picture on picture monitor.

4. Adjust HF COMP controls on 4 channel equalizer to eliminate banding between head channels. (Use range in vicinity of 3 on the dial.)

After the above procedure has been followed, video frequency response adjustments may be made for either monochrome or color operation of the tape recorder by the appropriate method below.

Monochrome Operation. The preferred method of obtaining the correct video frequency response during monochrome operation of the machine is as follows:

1. Play back a section of tape containing a multiburst signal.

2. Press OSCILLOSCOPE LINE OUT pushbutton on CRO/MON switcher and observe frequency response of waveform on waveform monitor.

3. Adjust H. FREQ. COMP control on 2 x 1 switcher for flat frequency response as observed on waveform monitor. (Clockwise rotation of the H. FREQ. COMP control increases the amplitude of the high frequency signal components.)

4. If a satisfactory frequency response cannot be obtained in step 3, check to make sure the 4 channel equalizer adjustments are properly made to eliminate banding between head channels. Readjust the 4 channel equalizer controls if necessary, and then adjust the H. FREQ. COMP control on the 2 x 1 switcher to obtain a flat frequency response.

If a multiburst signal is not available, the video frequency response adjustment may be made by an alternate method while playing back tape containing normal monochrome picture content:

1. Press MONITOR LINE OUT and OSCILLOSCOPE LINE OUT pushbuttons on CRO/MON switcher.

2. Adjust H. FREQ. COMP control on 2 x 1 switcher to obtain best picture on picture monitor (sharp and noise-free), while eliminating observable overshoots and noise on the waveform appearing on the waveform monitor.

3. If a satisfactory frequency response cannot be obtained in step 2, refer to step 4 above.

Color Operation. The correct video frequency response may be obtained during color operation of the machine by the following method:

1. Play back a color bar signal and observe chroma content on oscilloscope with OSCILLOSCOPE DEMOD OUT pushbutton pressed on CRO/MON switcher.

2. Adjust H. FREQ. COMP control on 2 x 1 switcher for normal chroma level.

3. If normal chroma level cannot be obtained, refer to step 4 under *Monochrome Operation.*

An alternate method of obtaining the correct video frequency response during color operation of the machine may be made while playing back tape containing normal color picture content:

Press OSCILLOSCOPE DEMOD OUT pushbutton on CRO/MON switcher and adjust H. FREQ. COMP control on 2 x 1 switcher for normal burst amplitude on oscilloscope (40 IRE units), or press LINE OUT pushbutton on the color monitor switcher and adjust H. FREQ. COMP control for normal chroma level as observed on the color monitor.

MAINTENANCE

FM Balance

Adjust the balance controls (A-BAL and B-BAL) in the following manner:

1. Place machine in wind mode and adjust FORWARD-REVERSE control so that there is no tape motion.

2. Press pushbutton labeled 2 X 1 OUT on CRO/MON switcher (unit 307) and observe waveform on waveform monitor (unit 306).

3. Adjust A-BAL and B-BAL controls to minimize switching spikes. (Coordinated adjustment of these controls should cause the spikes to almost disappear.) Figure S-4 shows switching spikes resulting from misadjustment of the balance controls.

NOTE: An approximate dc balance may be obtained by alternately connecting a vacuum-tube voltmeter to test points TP12 (A-BAL) and TP10 (B-BAL) while adjusting the balance controls to obtain minimum dc unbalance.

Synchroguide

Correct operation of the synchroguide circuit is dependent upon the proper phase and frequency adjustments of transformer T3. An external oscilloscope, comparable to the Tektronix Type 535, may be used in making the following adjustments:

1. Place machine in setup mode.

2. Jumper terminals C and D of transformer T3 with clip lead (refer to chassis rear view, figure S-19, to locate T3).

3. Connect oscilloscope input probe to test point TP13 (SG FREQ.). (Trigger oscilloscope with sync obtained at sync output jack J8.)

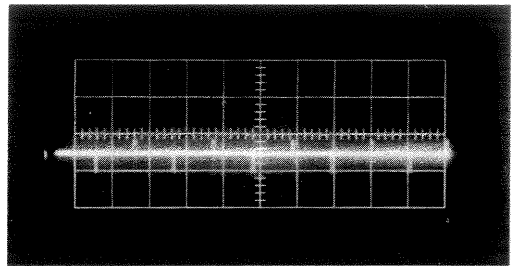


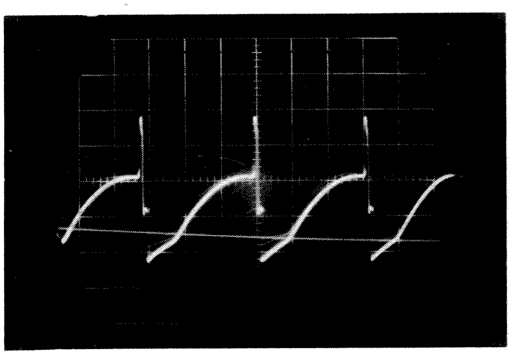
Figure S-4. Switching Spikes with Machine in WIND and Balance Controls Unbalanced

4. Adjust frequency slug located on the top of transformer T3 for locking as indicated by waveform in figure S-5. (Note that the correct position of the sync pulse with respect to the sawtooth waveform is with approximately 25% of the sync pulse width appearing at the peak of the sawtooth waveform as shown in figure S-5B.)

5. Remove clip lead from terminals C and D of transformer T3.

6. Connect oscilloscope probe to TP14 (SG PHASE) and adjust phase slug, located on the bottom of transformer T3 (rear of chassis), for waveform having equal amplitude of peaks as shown in figure S-6. If necessary, readjust the frequency slug to keep the oscillator locked while making the phase adjustment.

If transformer T3 cannot be adjusted as outlined above, check tubes and components common to the synchroguide circuit. Figures S-16D through S-17H show typical waveforms in the synchroguide circuit which may be useful in trouble-shooting.



A. Waveform at TP13

B. Waveform at TP13 Expanded (Horizontal Sweep Rate: 1 usec/cm)

Figure S-5. Correct Frequency Adjustment of T3

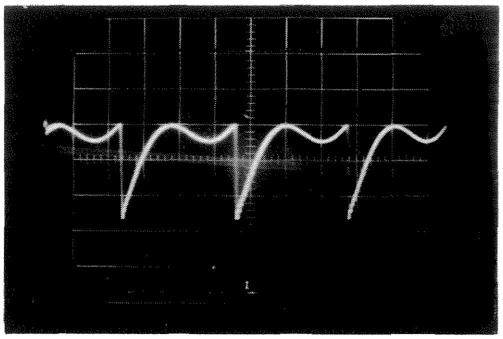


Figure S-6. Waveform at TP14 with Correct Phase Adjustment of T3 (Note Equal Amplitude of Peaks)

Pushout Pulse Adjustment

The 960-cycle pushout pulse developed by V28A may be varied in width by the adjustment of screwdriver control PO PULSE. The procedure for adjusting the pushout pulse width, using a Tektronix Type 535 oscilloscope or equivalent, is outlined below:

1. Place machine in setup.

2. Connect oscilloscope input probe to the plate of sync adder V6A (pin 1). (Trigger oscilloscope with sync from sync output jack J8.)

3. Adjust PO PULSE control so that the trailing edge of the pushout pulse falls 0.4 microsecond before the sync pulse trailing edge (figure S-7). (The 960-cycle pushout pulse appears as a faint outline in comparison with the 15.75 kc pushout pulse due to its relatively low repetition rate.) Also note that the leading edge of the 960-cycle pulse appears 0.4 microsecond after the sync pulse leading edge. (A slight adjustment of the frequency slug located on the top of transformer T3 may be necessary to obtain the correct waveform.)

4. Check the PO PULSE adjustment by observing that the 15.75 kc pushout pulse falls within the equalizing pulse interval and that the 960-cycle pushout pulse falls within the horizontal sync interval as shown in figure S-7.

Failure to obtain the correct 960-cycle pushout pulse may be due to a defective tube (V28) or associated circuit components. Note that the pulse is not present in the waveform at V6A, pin 1, when the recorder is operated in the monochrome rf copy mode.

Peaking Coil Adjustment

Peaking coil L2, in the plate circuit of equalizer stage V4, has been adjusted at the factory and should require no further adjustment. If the peaking coil or associated circuit components must be replaced, it may be necessary to adjust the coil. Test equipment required in making the adjustment consists of the following:

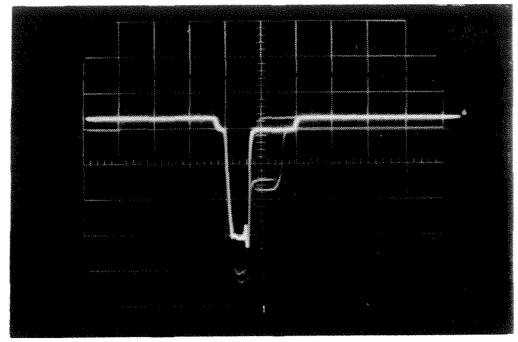


Figure S-7. 960-Cycle and 15.75 kc Pushout Pulses at Plate of V6A (Pin 1)

1. Wide-band oscilloscope (Tektronix Type 535 or equivalent).

2. Video sweep generator (0 to 10 mc sweep).

To adjust the coil, follow the procedure below:

1. Place machine in stop mode.

2. Connect sweep generator to fm input jack J6, and remove gating diode V21.

3. Adjust sweep generator output for 0.5 volt peak-to-peak.

4. Connect oscilloscope input probe to test point TP1 (FM OUT).

5. Set high frequency compensation control (H. FREQ. COMP) at 0.

6. Adjust peaking coil (above and to the left of H. FREQ. COMP control) to obtain a peak at 9 mc (figure S-8).

7. Check frequency response with H. FREQ. COMP control at maximum and minimum, and compare with figure S-8.

If the frequency response curve cannot be obtained by the above procedure, check fm amplifiers (V12 and V7), equalizer (V4), fm output stage (V1), and associated circuit components.

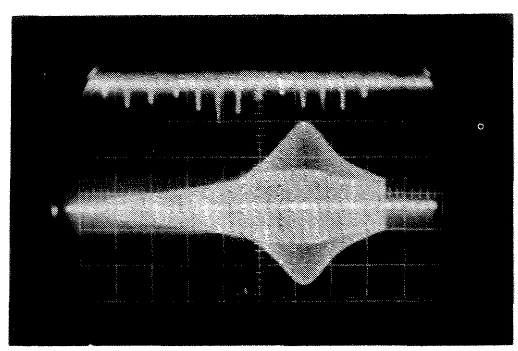


Figure S-8. Waveforms Obtained with H. FREQ. COMP Control Minimum (Note Peak at 9 mc), and Maximum. (Frequency Markers Range from 0 to 12 mc, Left to Right)

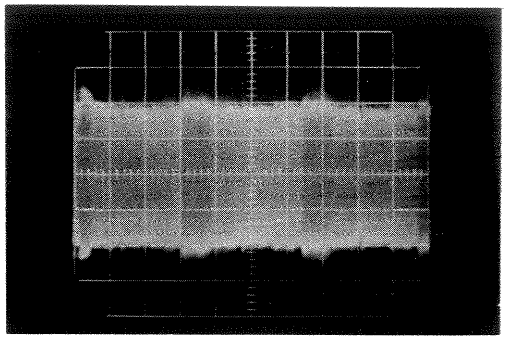


Figure S-9. Balanced FM Output Signal at TP1

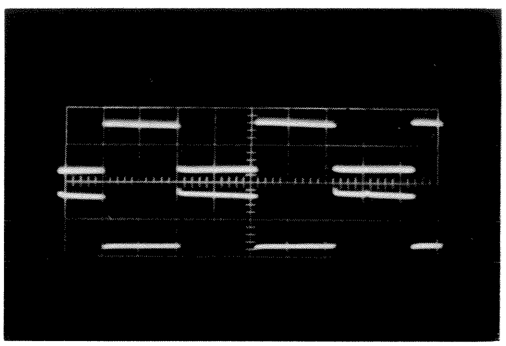


Figure S-10. Waveforms at Cathodes (Pin 5) of Gating Diodes V17, V21, V25 (top); V18, V22, V26 (bottom)

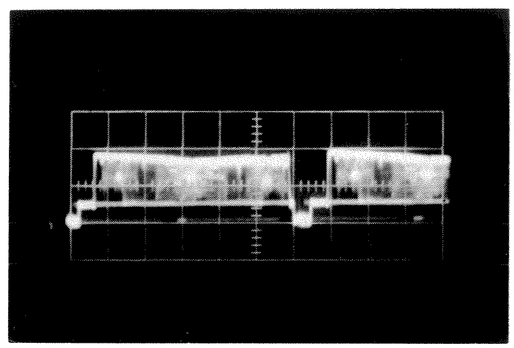


Figure S-11. Composite Video Input Signal at TP6

FM Output

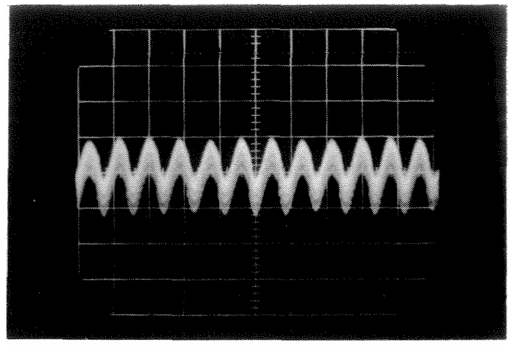
The combined fm output signal is shown in figure S-9 as it appears at test point TP1 (FM OUT). To check the frequency response of the output signal, proceed as in steps 1 through 5 of *Peaking Coil Adjustment,* with H. FREQ. COMP control maximum (fully clockwise).

The gain of the fm amplifier stages should be greater than 4 (2.0 volts peak-to-peak), at 1 mc, and may be checked by the above procedure. (It should be possible to drive the amplifier to 3.0 volts peak-to-peak output without noticeable distortion or compression of the output signal.)

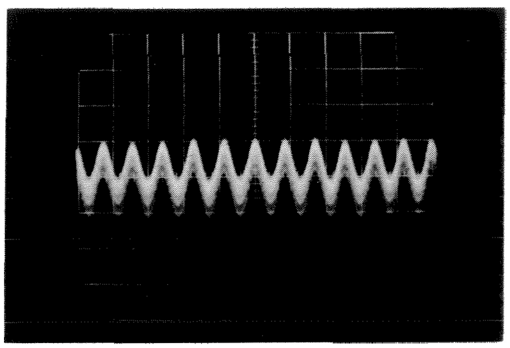
If the fm output signal does not appear at TP1, with fm input signals applied to input jacks J6 and J7, check for correct waveforms at the common cathodes of the gating diodes (figure S-10). If the correct waveforms are present, isolate the trouble by a point-to-point check of the succeeding amplifier stages, utilizing typical waveforms shown in figures S-15H through S-16C and voltages indicated in the *Voltage Table* adjacent to the schematic diagram (figure S-20). If the correct waveforms do not appear at the cathodes of the gating diodes, check switching driver stages A and B (V23 and V27). Improper operation of these stages may necessitate signal-tracing back through multivibrator stages V14 and V9. Since correct multivibrator operation is dependent upon the 960-cycle and synchroguide pulse timing, it may also be necessary to check the 960-cycle input and synchroguide stages.

Sync Separation

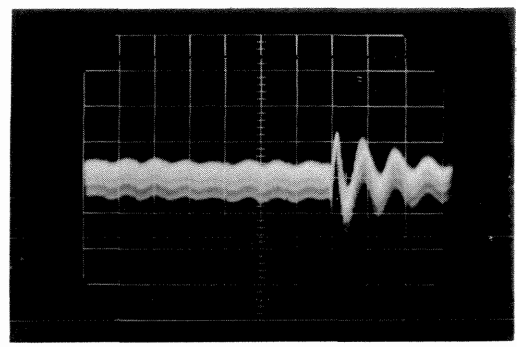
The video input signal applied to input jack J1● is shown in figure S-11 as it appears at test point TP6 (VIDEO IN). The separated sync output may be observed at test point TP4 (SYNC OUT), and should have an amplitude of 4 ± .5 volts.



A. Excessive Guide Pressure of 1 mil.



B. Deficient Guide Pressure of 1 mil.



C. Correct Guide Pressure (Zero Error).

Figure S-12. Guide Servo Error Signal at TP15

If the correct sync pulse output does not appear at TP4, isolate the trouble by a point-to-point check of each stage in the sync separation section, utilizing typical waveforms shown in figures S-13A through S-13H and voltages indicated in the *Voltage Table* adjacent to the schematic diagram (figure S-20).

Guide Servo Error Signal and DC Bias

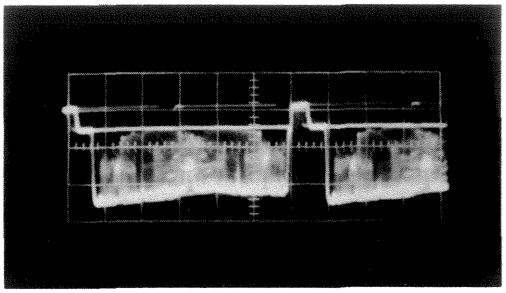
The 960-cycle error signal is fed to the guide servo (unit 506) from jack J13, pins 15 and 16. Test point TP15 (960 ERROR) may be utilized in observing the error signal which should have an amplitude of approximately 75 millivolts for a 1 mil error in guide position and should occur at a 960-cycle rate (figure S-12). If the error signal is not apparent at TP15, check tube V5, transformer T4, and the 960-cycle tuned circuit consisting of coil L3 and capacitor C80.

The dc bias voltage is fed to the guide servo from jack J13, pin 14 (pin 13 is ground), and may be observed at test point TP16 (DC BIAS). If the bias voltage is not present, check to make sure the video input signal level is approximately 1 volt peak-to-peak. If the normal video input signal is present, check video amplifier V24, sync clipper V20, cathode follower V13, and associated circuit components.

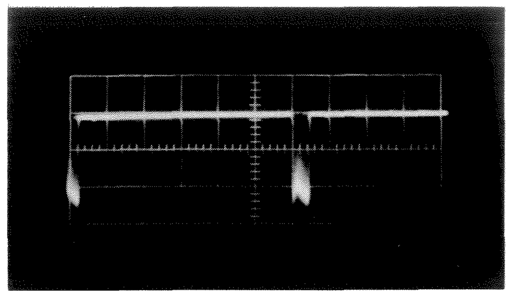
General

Figures S-13 through S-18 show typical waveforms obtained throughout the unit, with amplitudes and oscilloscope horizontal sweep-rates indicated. The waveforms were obtained with a Tektronix Type 535 oscilloscope.

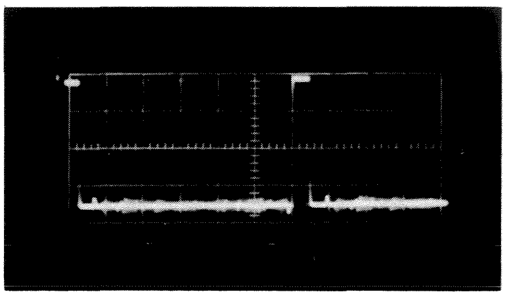
The *Voltage Table,* located adjacent to the schematic diagram (figure S-20), indicates typical tube-socket voltages with respect to ground, obtained with a vacuum-tube voltmeter. All voltages are dc unless otherwise specified.



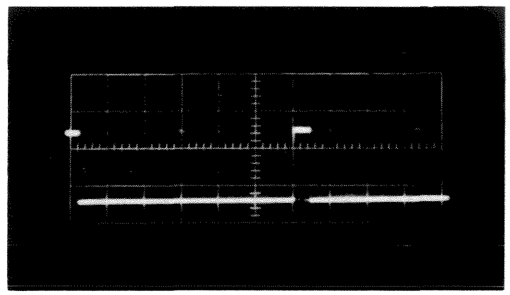
A. V24 Pius 2, 9 (20 volts/cm; 10 usec/cm)



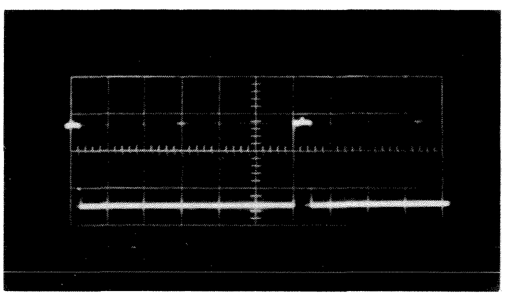
B. V20 Pin 3 (10 volts/cm; 10 usec/cm)



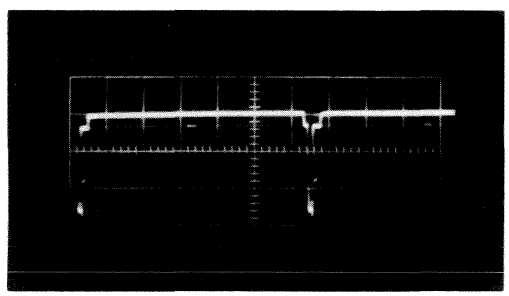
C. V20 Pin 9 (10 volts/cm; 10 usec/cm)



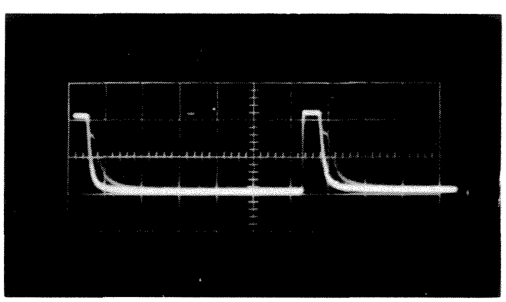
D. V16 Pin 8 (10 volts/cm; 10 usec/cm)



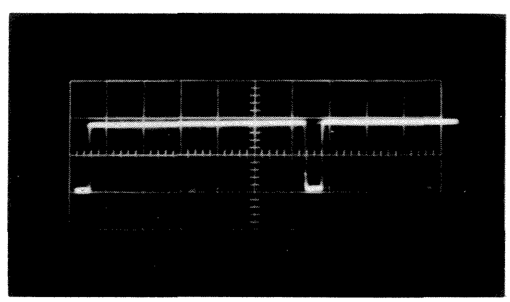
E. V6 Pin 2 (10 volts/cm; 10 usec/cm)



F. V6 Pin 1 (20 volts/cm; 10 usec/cm)

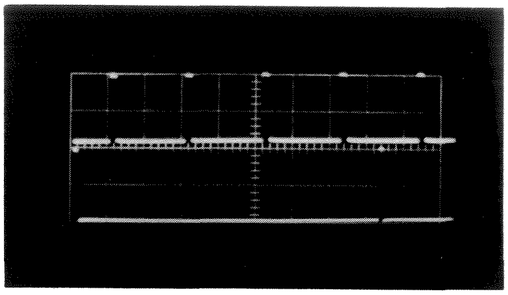


G. V6 Pin 6 (20 volts/cm; 10 usec/cm)

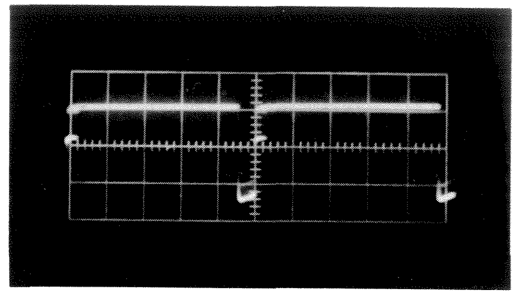


H. TP4 (2 volts/cm; 10 usec/cm)

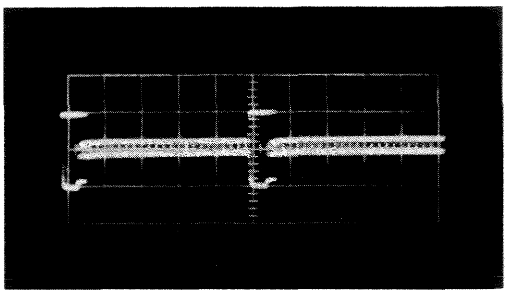
Figure S-13. Typical Waveforms



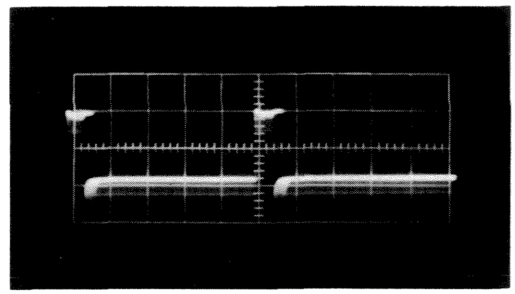
A. TP2 (top); TP3 (bottom). (2 volts/cm; 500 usec/cm)



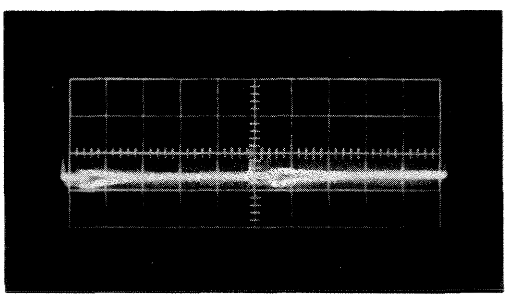
B. V8 Pins 2, 5, 6 (20 volts/cm; 200 usec/cm)



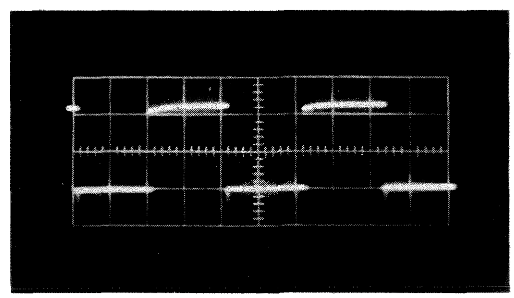
C. V9 Pin 1 (top); V9 Pin 6 (bottom). (50 volts/cm; 200 usec/cm)



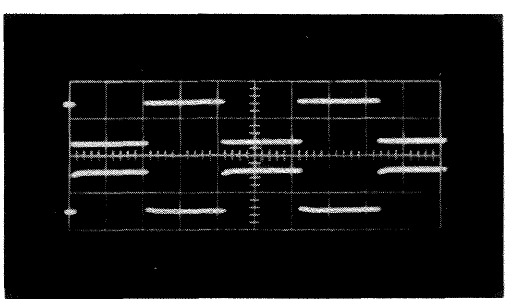
D. V9 Pin 7 (10 volts/cm; 200 usec/cm)



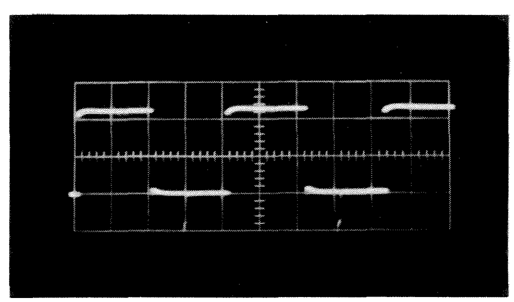
E. CR8 (0.5 volt/cm; 200 usec/cm)



F. V14 Pin 7 (10 volts/cm; 500 usec/cm)

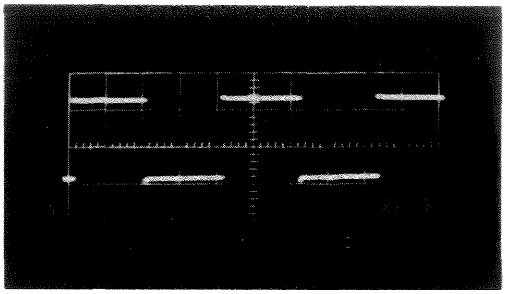


G. V14 Pin 1 (top); V14 Pin 6 (bottom). (50 volts/cm; 500 usec/cm)

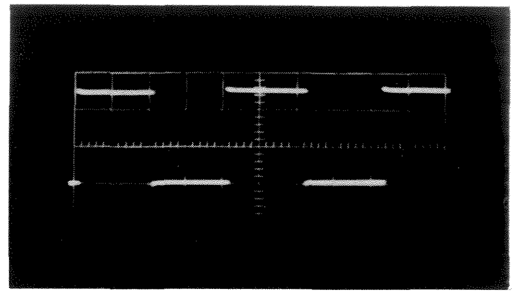


H. V14 Pin 2 (10 volts/cm; 500 usec/cm)

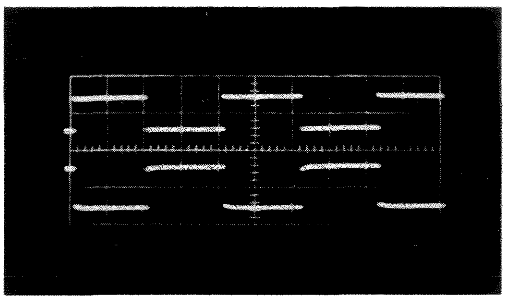
Figure S-14. Typical Waveforms



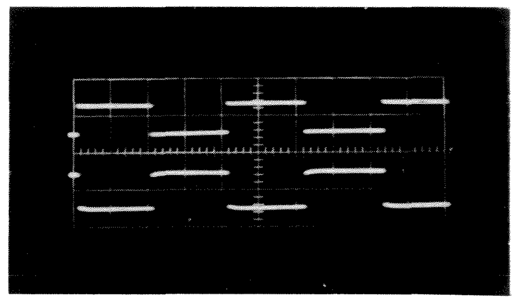
A. V19 Pin 7 (5 volts/cm; 500 usec/cm)



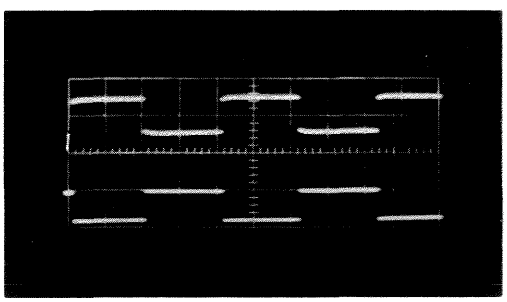
B. V19 Pins 3, 6 (2 volts/cm; 500 usec/cm)



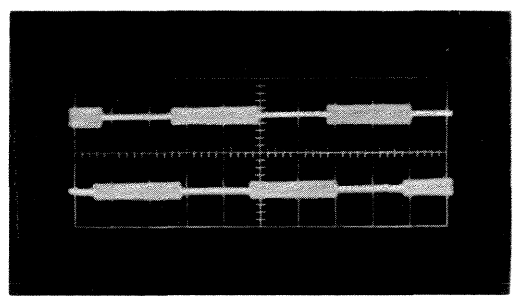
C. V19 Pin 9 (top); V19 Pin 1 (bottom).



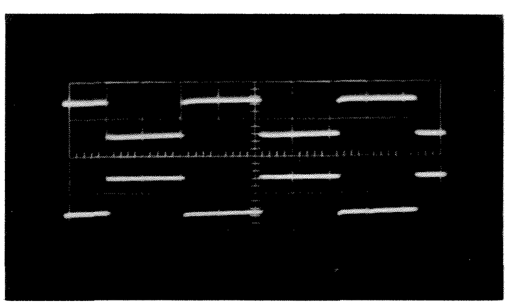
D. V27 Pin 3 (top); V27 Pin 6 (bottom). (20 volts/cm; 500 usec/cm)



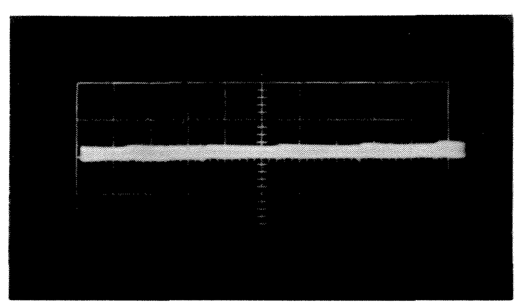
E. V23 Pin 6 (top); V23 Pin 3 (bottom). (20 volts/cm; 500 usec/cm)



F. TP7 (top); TP8 (bottom). (0.5 volt/cm; 500 usec/cm)

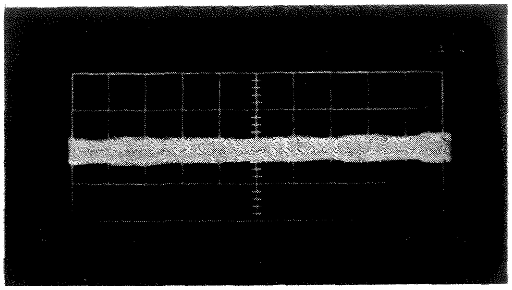


G. V17 Pin 7 (top); V18 Pin 7 (bottom). (10 volts/cm; 500 usec/cm)

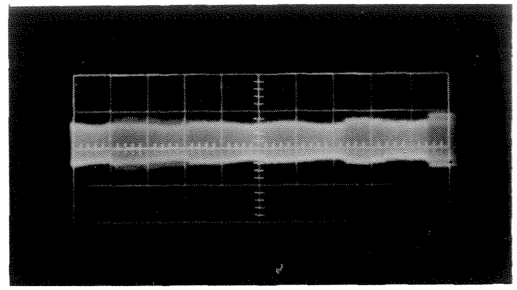


H. V12 Pin 2 (0.5 volt/cm; 500 usec/cm)

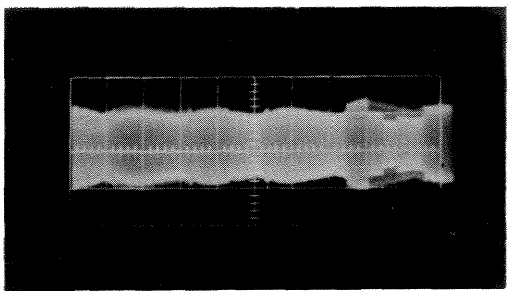
Figure S-15. Typical Waveforms



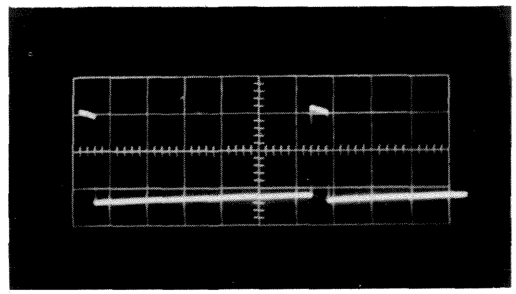
A. V7 Pin 2 (0.5 volt/cm; 500 usec/cm)



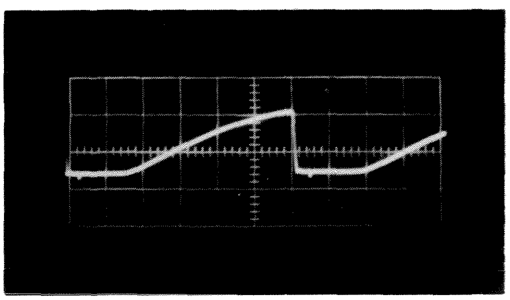
B. V4 Pins 2, 9 (0.5 volt/cm; 500 usec/cm)



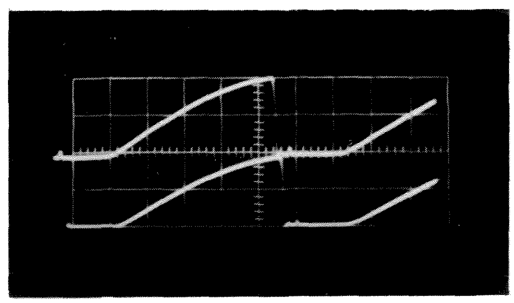
C. TP1 (0.5 volt/cm; 500 usec/cm)



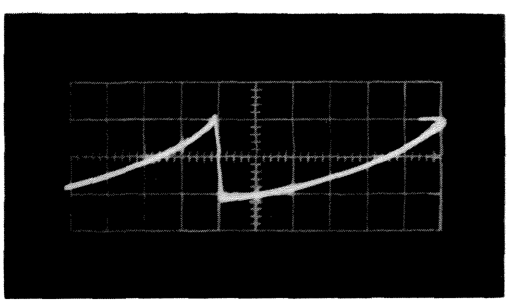
D. V11 Pin 2 (10 volts/cm; 10 usec/cm)



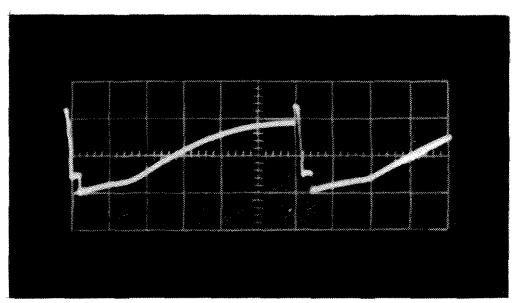
E. V2 Pin 8 (20 volts/cm; 10 usec/cm)



F. V2 Pin 3 (top); V2 Pin 7 (bottom). (20 volts/cm; 10 usec/cm)

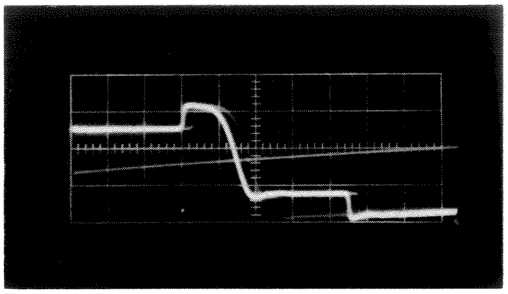


G. V2 Pin 2 (50 volts/cm; 10 usec/cm)

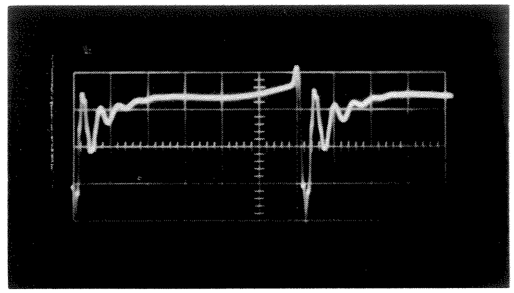


H. TP13 (10 volts/cm; 10 usec/cm)

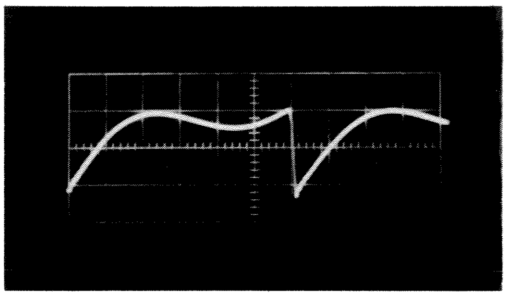
Figure S-16. Typical Waveforms



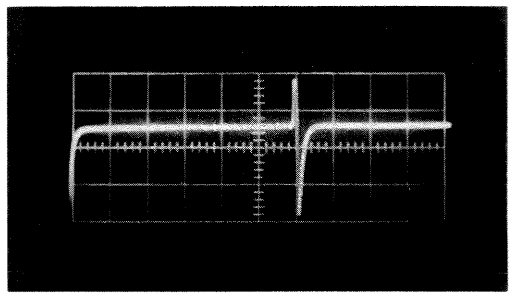
A. TP13 (20 volts/cm; 1 usec/cm)



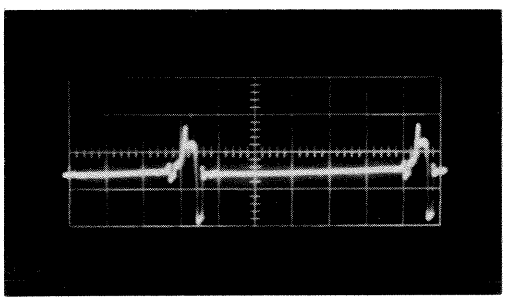
B. V5 Pin 7 (100 volts/cm; 10 usec/cm)



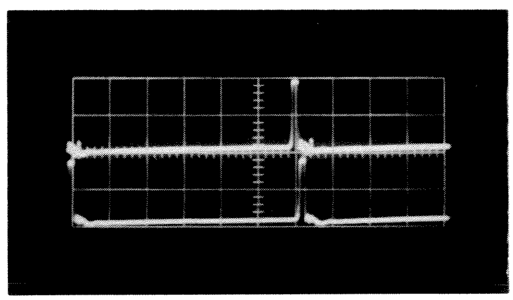
C. TP14 (50 volts/cm; 10 usec/cm)



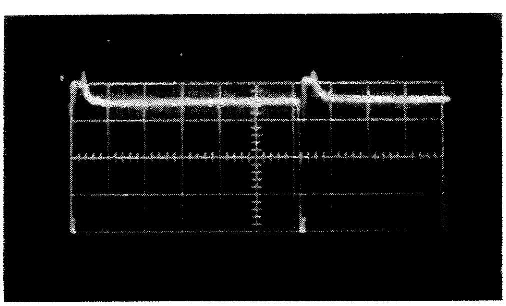
D. V10 Pin 7, Normal Mode (5 volts/cm; 10 usec/cm)



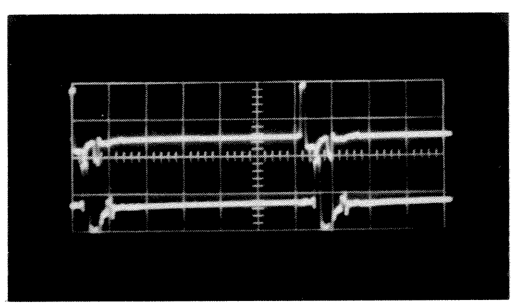
E. V10 Pin 7, RF Copy Mode (5 volts/cm; 10 usec/cm)



F. V15 Pin 8 (top); V10 Pin 1 (bottom). (10 volts/cm; 10 usec/cm)

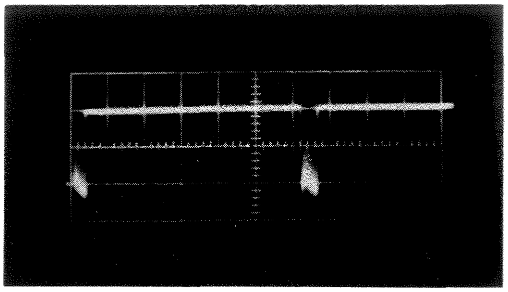


G. V15 Pin 2, RF Copy Mode (2 volts/cm; 10 usec/cm)

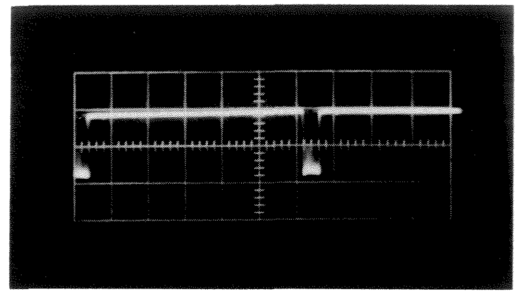


H. V10 Pin 7 (10 volts/cm; 10 usec/cm), (top). V15 Pin 1 (5 volts/cm; 10 usec/cm), (bottom).

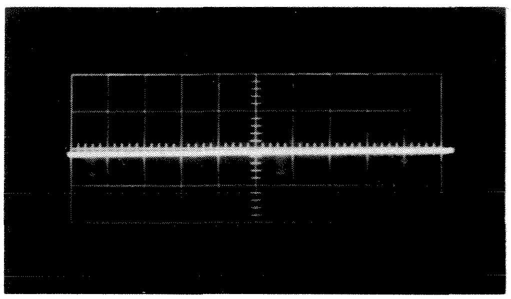
Figure S-17. Typical Waveforms



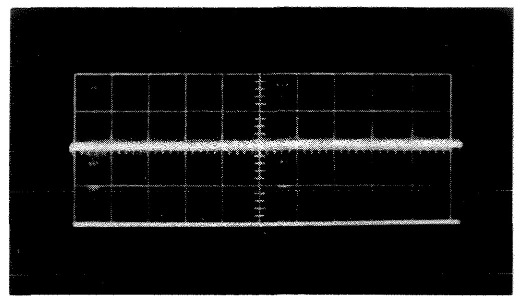
A. V13 Pin 2 (10 volts/cm; 10 usec/cm)



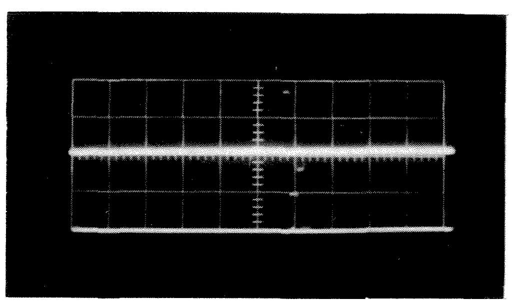
B. V13 Pin 3 (10 volts/cm; 10 usec/cm)



C. V28 Pin 2 (10 volts/cm; 200 usec/cm)



**D. V28 Pin 1, 960 Trigger (10 volts/cm; 200 usec/cm), (top).
V28 Pin 7, 960 Trigger (10 volts/cm; 200 usec/cm), (bottom).**



**E. V28 Pin 1, Sync Trigger (10 volts/cm; 10 usec/cm), (top).
V28 Pin 7, Sync Trigger (10 volts/cm; 10 usec/cm), (bottom).**

Figure S-18. Typical Waveforms

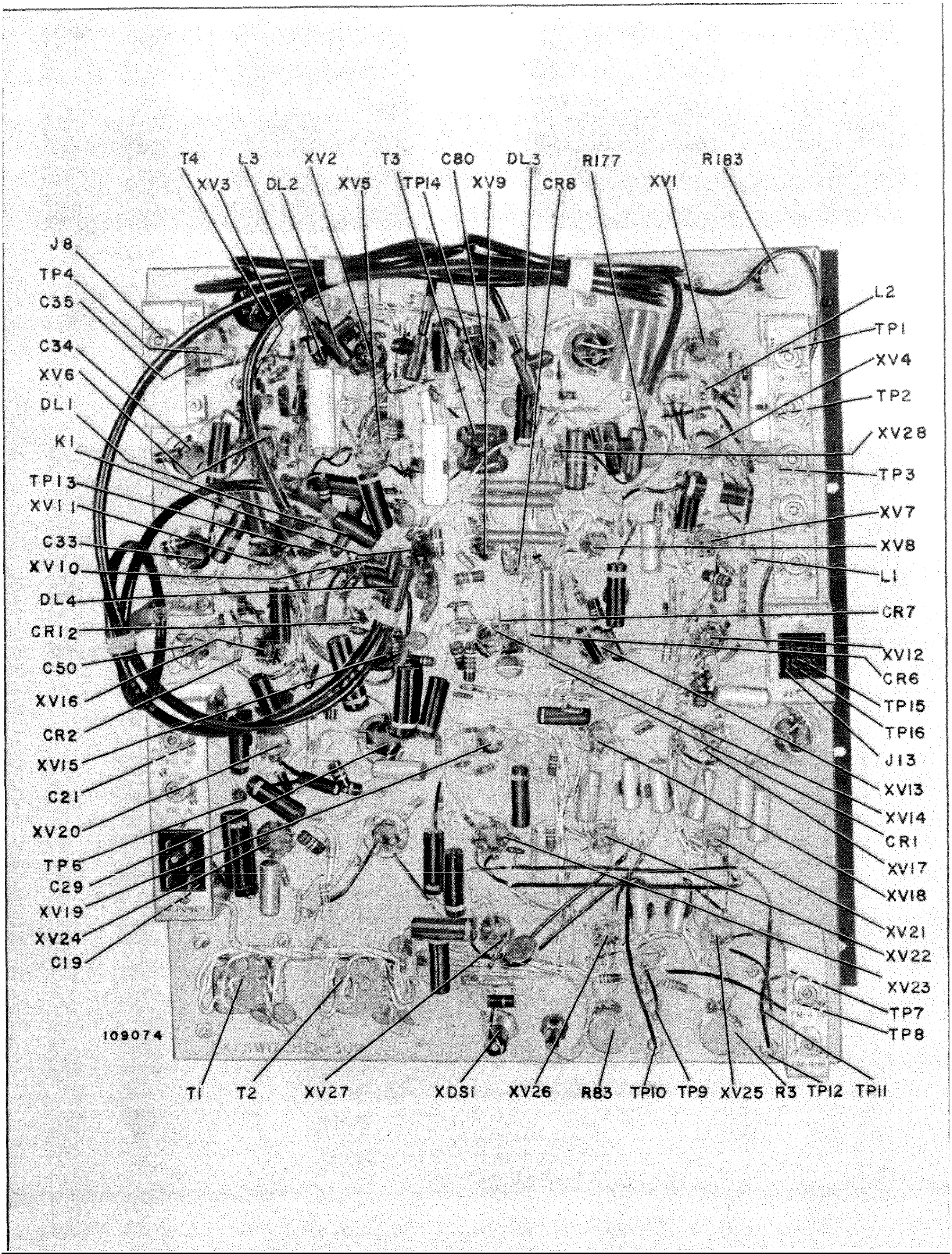


Figure S-19. Rear View of 2 x 1 Switcher

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
2 X 1 SWITCHER (8973625-502)			19
			CAPACITORS:
C1		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C2, C3		727851-23	mica, 100 μμf ±20%, 500 v char "B"
C4, C5		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C6		727851-23	mica, 100 μμf ±20%, 500 v char "B"
C7A/D	98408	458558-5	electrolytic, 20/20/20/20 μf -10 +50%, 450 v
C8		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C9		727851-23	mica, 100 μμf ±20%, 500 v char "B"
C10		727856-1	mica, 5 μμf ±20%, 500 v char "B"
C11		727851-23	mica, 100 μμf ±20%, 500 v char "B"
C12		735715-175	paper, 0.1 μf ±10%, 400 v
C13, C14		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C15	207187	737863-337	paper, 1 μf ±10%, 400 v
C16, C17		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C18		735715-175	paper, 0.1 μf ±10%, 400 v
C19A/B	99295	458557-5	electrolytic, 20/20 μf -10 +50%, 450 v
C20		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C21	204403	458557-6	electrolytic, 1000 μf -10 +40%, 15 v
C22		735715-175	paper, 0.1 μf ±10%, 400 v
C23		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C24A, B	218128	8971848-10	ceramic, 0.005/0.005 μμf -20 +80%, 150 v
C25 to C28		735715-175	paper, 0.1 μf ±10%, 400 v
C29A/D	98408	458558-5	electrolytic, 20/20/20/20 μf -10 +50%, 450 v
C30 to C32		735715-175	paper, 0.1 μf ±10%, 400 v
C33A/D	98408	458558-5	electrolytic, 20/20/20/20 μf -10 +50%, 450 v
C34	210286	458558-26	electrolytic, 500 μf -10 +100%, 50 v
C35	95914	458558-1	electrolytic, 125 μf -10 +50%, 350 v
C36, C37		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C38		727851-23	mica, 100 μμf ±20%, 500 v char "B"
C39			Not Used
C40 to C42		735715-175	paper, 0.1 μf ±10%, 400 v
C43		735715-83	paper, 0.47 μf ±10%, 200 v
C44, C45		735715-163	paper, 0.01 μf ±10%, 400 v
C46		735715-75	paper, 0.1 μf ±10%, 200 v
C47 to C49		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C50A, B, C51A, B	99295	458557-5	electrolytic, 20/20 μf -10 +50%, 450 v
C52		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C53		735715-179	paper, 0.22 μf ±10%, 400 v
C54 to C57		735715-175	paper, 0.1 μf ±10%, 400 v
C58		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C59		727853-109	mica, 27 μμf ±10%, 500 v char "D"
C60		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C61		727853-109	mica, 27 μμf ±10%, 500 v char "D"
C62		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C63		727856-123	mica, 100 μμf ±10%, 500 v char "B"
C64		727853-109	mica, 27 μμf ±10%, 500 v char "D"
C65		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C66		727853-109	mica, 27 μμf ±10%, 500 v char "D"
C67		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C68		727866-147	mica, 1000 μμf ±20%, 500 v char "B"
C69			Not Used
C70A/D	98408	458558-5	electrolytic, 20/20/20/20 μf -10 +50%, 450 v
C71			Not Used
C72		735715-175	paper, 0.1 μf ±10%, 400 v
C73 to C75		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C76		735715-175	paper, 0.1 μf ±10%, 400 v
C77		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C78			Not Used
C79		735715-179	paper, 0.22 μf ±10%, 400 v
C80A/D	98408	458558-5	electrolytic, 20/20/20/20 μf -10 +50%, 450 v
C81		727866-147	mica, 1000 μμf ±20%, 500 v char "B"
C82	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C83		727856-121	mica, 82 μμf ±10%, 500 v char "B"
C84		735715-171	paper, 0.047 μf ±10%, 400 v

Symbol No.	Stock No.	Drawing No.	Description
C85	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C86		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C87		984663-22	mica, 270 μμf ±5%, 1000 v char "D"
C88	223081	993026-485	mica, 10,000 μμf ±5%, 500 v char "F"
C89		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C90	99657	737818-81	paper, 0.001 μf ±10%, 400 v
C91	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C92		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C93		727851-135	mica, 330 μμf ±10%, 500 v char "B"
C94			Not Used
C95		727856-121	mica, 82 μμf ±10%, 500 v char "B"
C96 to C99		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C100		735715-175	paper, 0.1 μf ±10%, 400 v
C101		727856-102	mica, 10 μμf ±10%, 500 v char "B"
C102		735715-175	paper, 0.1 μf ±10%, 400 v
C103	91391	442901-74	electrolytic, 10 μf 450 v
C104		735715-79	paper, 0.22 μf ±10%, 200 v
C105		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
CR1	219245		Diode: type 1N2071
CR2	99483		Diode: type 1N54A
CR3 to CR5			Not Used
CR6 to CR8	99483		Diode: type 1N54A
CR9 to CR11			Not Used
CR12	219245		Diode: type 1N2071
DL1 to DL3	218103	8928790-12	Line: delay, 1.75 microseconds
DL4	222966	8928790-17	Line: delay, 3.60 microseconds
DS1	101857	872291-9	Lamp: indicating
F1	98682	8851771-18	Fuse: 1.5 amps 125 v slo-blo
J1 to J8	51800	255223-2	Connector: coax
J9			Not Used
J10, J11	51800	255223-2	Connector: coax
J12	51604	727969-3	Connector: male, 6 contact
J13	99165	727969-26	Connector: female, 4 contact
K1	222967	8520402-1	Relay
L1	209148	8825473-501	Coil: 2 microhenry
L2	210530	476933-4	Coil: peaking, 9/18 microhenry
L3	218141	8973781-1	Coil: torroid, 60 microhenry
P1 to P4			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P5	210715	8909771-501	Termination: coax
P6, P7			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
		8979037-1	Adapter
		8979036-3	Sleeve
P8 to P11			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P12	51607	727969-4	Connector: female, 6 contact
P13	99213	727969-27	Connector: male, 4 contact
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-140	160 ohms, ±5%, ½ w
R2	53658	458572-84	wire wound, 15,000 ohms, ±5%, 5 w
R3	206064	8971860-10	variable, 10,000 ohms, ±10%, 2 w
R4	53658	458572-84	wire wound, 15,000 ohms, ±5%, 5 w
R5		82283-74	10,000 ohms, ±10%, ½ w
R6		82283-142	200 ohms, ±5%, ½ w
R7		99126-79	27,000 ohms, ±10%, 2 w
R8		90496-82	47,000 ohms, ±10%, 1 w
R9, R10		82283-50	100 ohms, ±10%, ½ w
R11		82283-74	10,000 ohms, ±10%, ½ w
R12	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R13		82283-58	470 ohms, ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R14		82283-48	68 ohms, ±10%, ½ w
R15		82283-86	100,000 ohms, ±10%, ½ w
R16		82283-142	200 ohms, ±5%, ½ w
R17		99126-79	27,000 ohms, ±10%, 2 w
R18		90496-82	47,000 ohms, ±10%, 1 w
R19, R20		82283-50	100 ohms, ±10%, ½ w
R21		82283-86	100,000 ohms, ±10%, ½ w
R22	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R23		82283-58	470 ohms, ±10%, ½ w
R24		82283-48	68 ohms, ±10%, ½ w
R25		82283-94	470,000 ohms, ±10%, ½ w
R26		82283-50	100 ohms, ±10%, ½ w
R27		82283-51	120 ohms, ±10%, ½ w
R28, R29		82283-55	270 ohms, ±10%, ½ w
R30		82283-94	470,000 ohms, ±10%, ½ w
R31		82283-42	22 ohms, ±10%, ½ w
R32		82283-62	1000 ohms, ±10%, ½ w
R33		82283-90	220,000 ohms, ±10%, ½ w
R34		99126-79	27,000 ohms, ±10%, 2 w
R35		82283-142	200 ohms, ±5%, ½ w
R36		90496-82	47,000 ohms, ±10%, 1 w
R37		82283-52	150 ohms, ±10%, ½ w
R38		82283-90	220,000 ohms, ±10%, ½ w
R39	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R40		82283-53	180 ohms, ±10%, ½ w
R41		82283-98	1 meg ±10%, ½ w
R42		82283-52	150 ohms, ±10%, ½ w
R43			Not Used
R44		82283-94	470,000 ohms, ±10%, ½ w
R45		99126-82	47,000 ohms, ±10%, 2 w
R46		90496-62	1000 ohms, ±10%, 1 w
R47, R48		82283-52	150 ohms, ±10%, ½ w
R49		82283-53	180 ohms, ±10%, ½ w
R50		99126-70	4700 ohms, ±10%, 2 w
R51		99126-67	2700 ohms, ±10%, 2 w
R52		82283-94	470,000 ohms, ±10%, ½ w
R53		82283-66	2200 ohms, ±10%, ½ w
R54		82283-178	6200 ohms, ±5%, ½ w
R55		82283-152	510 ohms, ±5%, ½ w
R56		90496-76	15,000 ohms, ±10%, 1 w
R57		82283-94	470,000 ohms, ±10%, ½ w
R58		82283-52	150 ohms, ±10%, ½ w
R59		82283-60	680 ohms, ±10%, ½ w
R60		82283-70	4700 ohms, ±10%, ½ w
R61		82283-52	150 ohms, ±10%, ½ w
R62		82283-94	470,000 ohms, ±10%, ½ w
R63		82283-61	820 ohms, ±10%, ½ w
R64		99126-74	10,000 ohms, ±10%, 2 w
R65		90496-70	4700 ohms, ±10%, 1 w
R66		82283-62	1000 ohms, ±10%, ½ w
R67		82283-50	100 ohms, ±10%, ½ w
R68		90496-84	68,000 ohms, ±10%, 1 w
R69		82283-98	1 meg ±10%, ½ w
R70		82283-67	2700 ohms, ±10%, ½ w
R71		82283-98	1 meg ±10%, ½ w
R72		90496-71	5600 ohms, ±10%, 1 w
R73		99126-84	68,000 ohms, ±10%, 2 w
R74, R75		82283-52	150 ohms, ±10%, ½ w
R76		82283-94	470,000 ohms, ±10%, ½ w
R77 to R79		99126-62	1000 ohms, ±10%, 2 w
R80		82283-52	150 ohms, ±10%, ½ w
R81		82283-140	160 ohms, ±5%, ½ w
R82	53658	458572-84	wire wound, 15,000 ohms, ±5%, 5 w
R83	205064	8971860-10	variable, 10,000 ohms, ±10%, 2 w
R84	53658	458572-84	wire wound, 15,000 ohms, ±5%, 5 w

Symbol No.	Stock No.	Drawing No.	Description
R85		82283-86	100,000 ohms, ±10%, ½ w
R86		82283-59	560 ohms, ±10%, ½ w
R87		82283-70	4700 ohms, ±10%, ½ w
R88			Not Used
R89		82283-223	470,000 ohms, ±5%, ½ w
R90		90496-91	270,000 ohms, ±10%, 1 w
R91		99126-70	4700 ohms, ±10%, 2 w
R92		82283-94	470,000 ohms, ±10%, ½ w
R93		82283-52	150 ohms, ±10%, ½ w
R94, R95			Not Used
R96		82283-66	2200 ohms, ±10%, ½ w
R97			Not Used
R98		90496-91	270,000 ohms, ±10%, 1 w
R99		82283-52	150 ohms, ±10%, ½ w
R100		82283-94	470,000 ohms, ±10%, ½ w
R101		90496-199	47,000 ohms, ±5%, 1 w
R102		90496-198	43,000 ohms, ±5%, ½ w
R103, R104		82283-50	100 ohms, ±10%, ½ w
R105		82283-94	470,000 ohms, ±10%, ½ w
R106	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R107, R108		82283-50	100 ohms, ±10%, ½ w
R109		82283-94	470,000 ohms, ±10%, ½ w
R110	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R111		90496-50	100 ohms, ±10%, 1 w
R112		82283-89	180,000 ohms, ±10%, ½ w
R113			Not Used
R114		82283-86	100,000 ohms, ±10%, ½ w
R115	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R116		82283-93	390,000 ohms, ±10%, ½ w
R117, R118		90496-170	3000 ohms, ±5%, 1 w
R119		82283-74	10,000 ohms, ±10%, ½ w
R120		90496-83	56,000 ohms, ±10%, 1 w
R121		82283-150	430 ohms, ±5%, ½ w
R122		82283-52	150 ohms, ±10%, ½ w
R123		99126-83	56,000 ohms, ±10%, 2 w
R124 to R129			Not Used
R130		82283-54	220 ohms, ±10%, ½ w
R131		82283-50	100 ohms, ±10%, ½ w
R132		82283-94	470,000 ohms, ±10%, ½ w
R133, R134		82283-50	100 ohms, ±10%, ½ w
R135	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R136		82283-50	100 ohms, ±10%, ½ w
R137		90496-198	43,000 ohms, ±5%, ½ w
R138	59926	458572-73	wire wound, 7000 ohms, ±5%, 5 w
R139		82283-94	470,000 ohms, ±10%, ½ w
R140		90496-159	1000 ohms, ±5%, 1 w
R141		90496-199	47,000 ohms, ±5%, 1 w
R142		82283-94	470,000 ohms, ±10%, ½ w
R143		82283-54	220 ohms, ±10%, ½ w
R144		82283-94	470,000 ohms ±10%, ½ w
R145	45258	458572-62	wire wound, 3000 ohms, ±5%, 5 w
R146		82283-158	910 ohms, ±5%, ½ w
R147		82283-52	150 ohms, ±10%, ½ w
R148		82283-202	62,000 ohms, ±5%, ½ w
R149		82283-68	3300 ohms, ±10%, ½ w
R150		82283-202	62,000 ohms, ±5%, ½ w
R151		82283-161	1200 ohms, ±10%, ½ w
R152		99126-175	4700 ohms, ±5%, 2 w
R153		99126-184	11,000 ohms, ±5%, 2 w
R154		82283-74	10,000 ohms, ±10%, ½ w
R155		82283-202	62,000 ohms, ±5%, ½ w
R156		82283-161	1200 ohms, ±10%, ½ w
R157		99126-175	4700 ohms, ±5%, 2 w
R158		82283-202	62,000 ohms, ±5%, ½ w
R159		82283-64	1500 ohms, ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R160	219822	990189-409	fixed, film, 12,100 ohms, ±1%, 2 w
R161			Not Used
R162	219822	990189-409	fixed, film, 12,100 ohms, ±1%, 2 w
R163		99126-71	5600 ohms, ±10%, 2 w
R164		99126-184	11,000 ohms, ±5%, 2 w
R165		99126-71	5600 ohms, ±10%, 2 w
R166	219822	990189-409	fixed, film, 12,100 ohms, ±1%, 2 w
R167			Not Used
R168	219884	990189-405	fixed, film, 11,000 ohms, ±1%, 2 w
R169			Not Used
R170		82283-86	100,000 ohms, ±10%, ½ w
R171		82283-50	100 ohms, ±10%, ½ w
R172		99126-79	27,000 ohms, ±10%, 2 w
R173	213205	993008-92	wire wound, 3500 ohms, ±5%, 10 w
R174			Not Used
R175		82283-46	47 ohms, ±10%, ½ w
R176		82283-50	100 ohms, ±10%, ½ w
R177	206913	8971860-6	variable, 1000 ohms, ±10%, 2 w
R178, R179		82283-86	100,000 ohms, ±10%, ½ w
R180		82283-68	3300 ohms, ±10%, ½ w
R181		99126-74	10,000 ohms, ±10%, 2 w
R182		82283-94	470,000 ohms, ±10%, ½ w
R183	212133	8971860-120	variable, 2.5 meg ±20%, 2 w
R184, R185		90496-170	3000 ohms, ±5%, 1 w
R186		82283-98	1 meg ±10%, ½ w
R187		82283-66	2200 ohms, ±10%, ½ w
R188	45354	458572-77	wire wound, 10,000 ohms, ±5%, 5 w
R189		82283-128	51 ohms, ±5%, ½ w
R190		82283-62	1000 ohms, ±10%, ½ w
R191		82283-68	3300 ohms, ±10%, ½ w
R192		82283-217	270,000 ohms, ±5%, ½ w
R193		82283-86	100,000 ohms, ±5%, ½ w
R194		82283-183	10,000 ohms, ±5%, ½ w
R195		82283-74	10,000 ohms, ±10%, ½ w
R196		90496-170	3000 ohms, ±5%, 1 w
R197		82283-54	220 ohms, ±10%, ½ w
R198		99126-74	10,000 ohms, ±10%, 2 w
R199		82283-66	2200 ohms, ±10%, ½ w
R200 to R206			Not Used
R207		82283-61	820 ohms, ±10%, ½ w
R208		82283-74	10,000 ohms, ±10%, ½ w
R209		99126-74	10,000 ohms, ±10%, 2 w
R210		90496-70	4700 ohms, ±10%, 1 w
R211		82283-92	330,000 ohms, ±10%, ½ w
R212		82283-97	820,000 ohms, ±10%, ½ w
R213		90496-85	82,000 ohms, ±10%, 1 w
R214		90496-88	150,000 ohms, ±10%, 1 w
R215		82283-69	3900 ohms, ±10%, ½ w
R216		90496-81	39,000 ohms, ±10%, 1 w
R217		90496-210	130,000 ohms, ±5%, 1 w
R218		82283-201	56,000 ohms, ±5%, ½ w
R219 to R225			Not Used
R226		99126-74	10,000 ohms, ±10%, 2 w
R227		82283-170	3000 ohms, ±5%, ½ w
R228		82283-84	68,000 ohms, ±10%, ½ w
R229		82283-94	470,000 ohms, ±10%, ½ w
R230		99126-66	2200 ohms, ±10%, 2 w
R231		82283-94	470,000 ohms, ±10%, ½ w
T1, T2	95539	443975-3	Transformer: filament
T3	76440	177816-1	Transformer: hor. osc.
T4	218143	8439025-1	Transformer: audio
TP1 to TP4	208983	8825493-7	Jack: tip, yellow
TP5			Not Used
TP6 to TP16	208983	8825493-7	Jack: tip, yellow
XADS	208080	990788-507	Lens: clear

Symbol No.	Stock No.	Drawing No.	Description
XDS	208458	990789-5	Holder: lamp
XF1	48894	99088-2	Holder: fuse
XK1	222968	8520403-1	Socket: relay
XV1 to XV7	94926	737870-14	Socket: tube, 9 pin
XV8	94925	737867-14	Socket: tube, 7 pin
XV9 to XV16	94926	737870-14	Socket: tube, 9 pin
XV17, XV18	94925	737867-14	Socket: tube, 7 pin
XV19, XV20	94926	737870-14	Socket: tube, 9 pin
XV21, XV22	94925	737867-14	Socket: tube, 7 pin
XV23, XV24	94926	737870-14	Socket: tube, 9 pin
XV25, XV26	94925	737867-14	Socket: tube, 7 pin
XV27, XV28	94926	737870-14	Socket: tube, 9 pin
			Miscellaneous:
	212940	8905470-1	Dial: calibrated, for R177
	30075	712336-507	Knob: black
	99244	8849946-1	Knob: red
	211776	8905465-6	Pointer: for R177
	219282	486041-7	Terminal: stand-off, 4-40 tap .75" lg.
	97821	486041-10	Terminal: stand-off 4-40 tap .90" lg.

VOLTAGE TABLE†

Tube Symbol	Tube Type	Pin Number 1	2	3	4	5	6	7	8	9
V1	5687	140	0	4.5	*	*	148	102	*	275
V2	12BH7	255	0	20	**	**	255	19	32	**
V3	6CL6	8.3	—33	155	***	***	265	0	155	—33
V4	6CL6	4.7	3.2	103	***	***	180	4.7	103	3.2
V5	6CG7	280	—15	4	***	***	210	—67	0.4	NC
V6	6AN8	245	0	11.6	***	***	150	88	—2	0
V7	6AW8A	138	99	280	***	***	1.3	0.2	80	160
V8	6AU6	—2.8	107	****	****	107	107	1.1	NC	NC
V9	5963	190	108	112	**	**	220	90	112	**
V10	12AT7	260	95	95	**	**	86	0	5.5	**
V11	5687	280	91	100	*	*	103	55	*	280
V12	6AW8A	132	127	280	***	***	1.2	0	95	160
V13	12AT7	280	29	34	**	**	110	0	5	**
V14	5963	235	114	128	**	**	235	114	128	**
V15	6AN8	122	0	2.5	***	***	245	255	—1.7	16
V16	12AT7	250	56	94	**	**	275	75	94	**
V17	6AL5	134	134	****	****	140	NC	135	NC	NC
V18	6AL5	136	136	****	****	142	NC	135	NC	NC
V19	5687	265	82	100	*	*	100	82	*	260
V20	6AU8	0	—33	200	***	***	3.1	0	124	180
V21	6AL5	135	135	****	****	140	NC	135	NC	NC
V22	6AL5	138	138	****	****	142	NC	135	NC	NC
V23	5687	275	125	135	*	*	135	125	*	275
V24	6AW8A	120	76	275	***	***	2.8	1.1	102	180
V25	6AL5	140	140	****	****	140	NC	135	NC	NC
V26	6AL5	140	140	****	****	142	NC	135	NC	NC
V27	5687	275	125	138	*	*	138	130	*	275
V28	12AT7	126	—0.4	0	**	**	245	—12	0.35	**

† Typical (±10%) dc voltage-to-ground measurements at the tube-socket terminals using a vacuum-tube voltmeter.
* 6.3 volts ac between pin 8 and either of pins 4 or 5.
** 6.3 volts ac between pin 9 and either of pins 4 or 5.
*** 6.3 volts ac between pins 4 and 5.
**** 6.3 volts ac between pins 3 and 4.

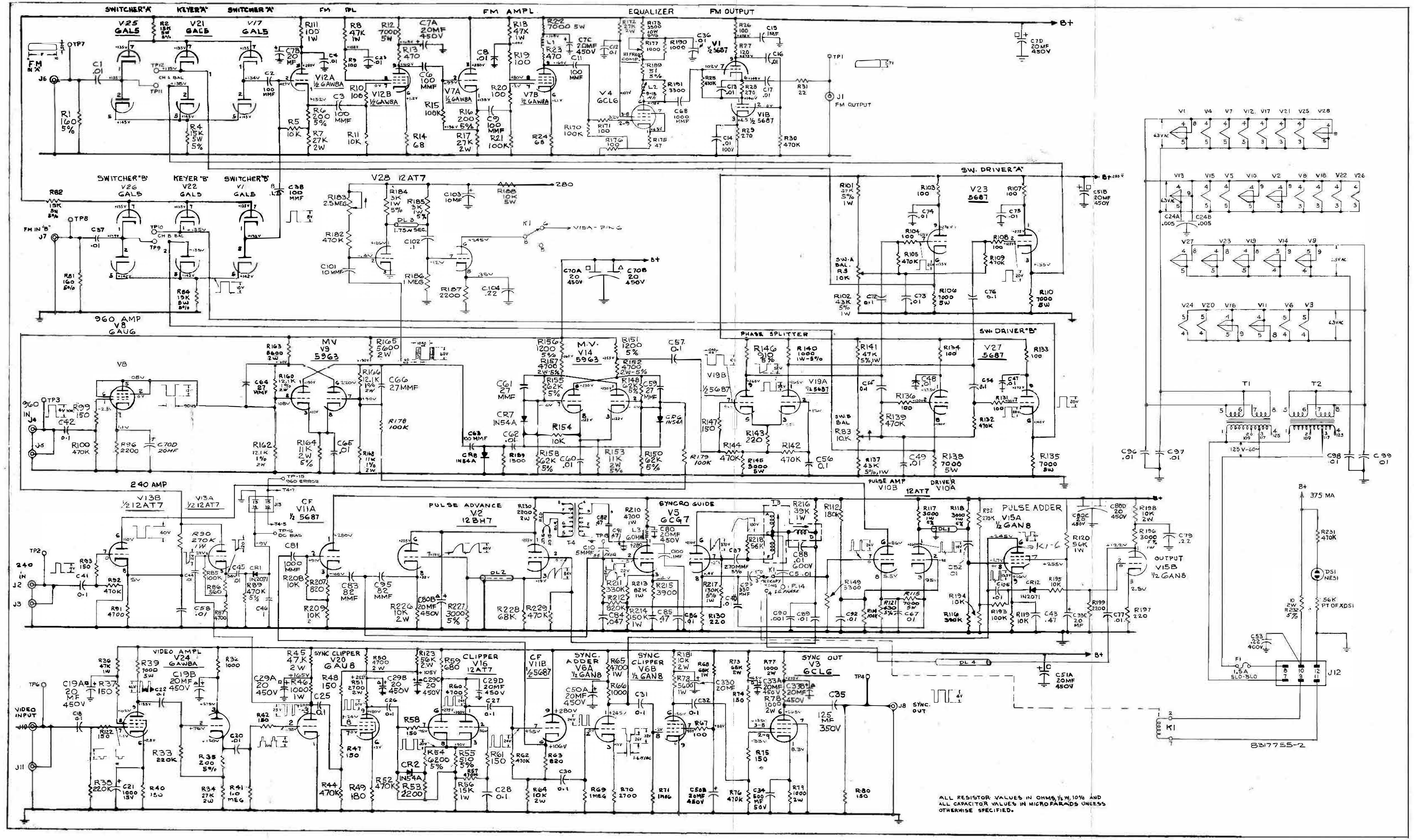
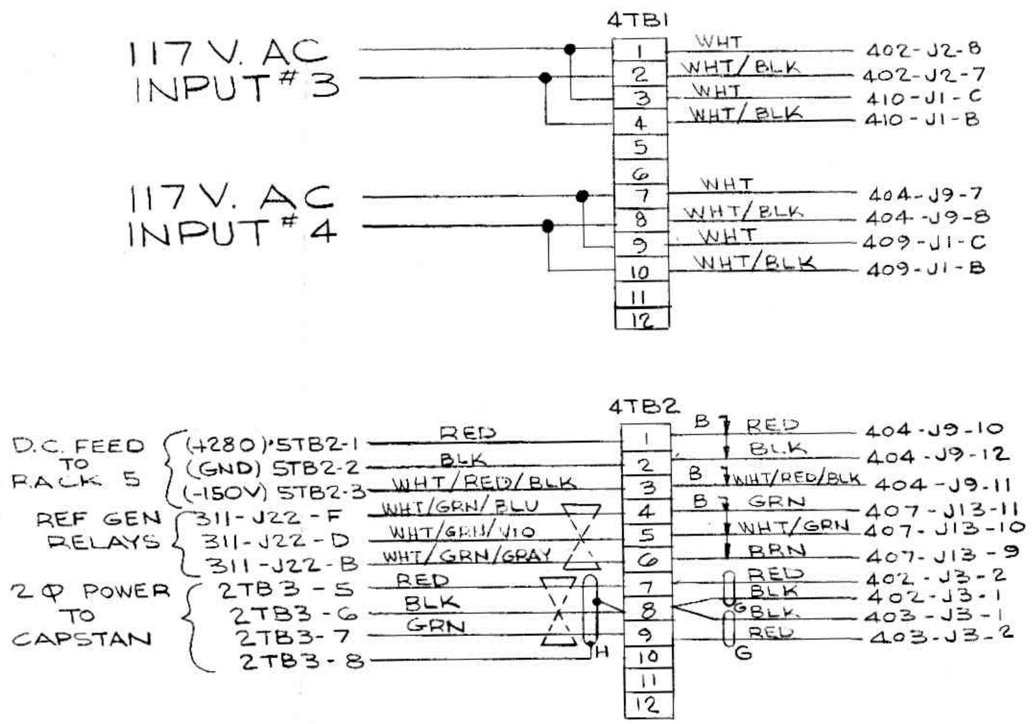
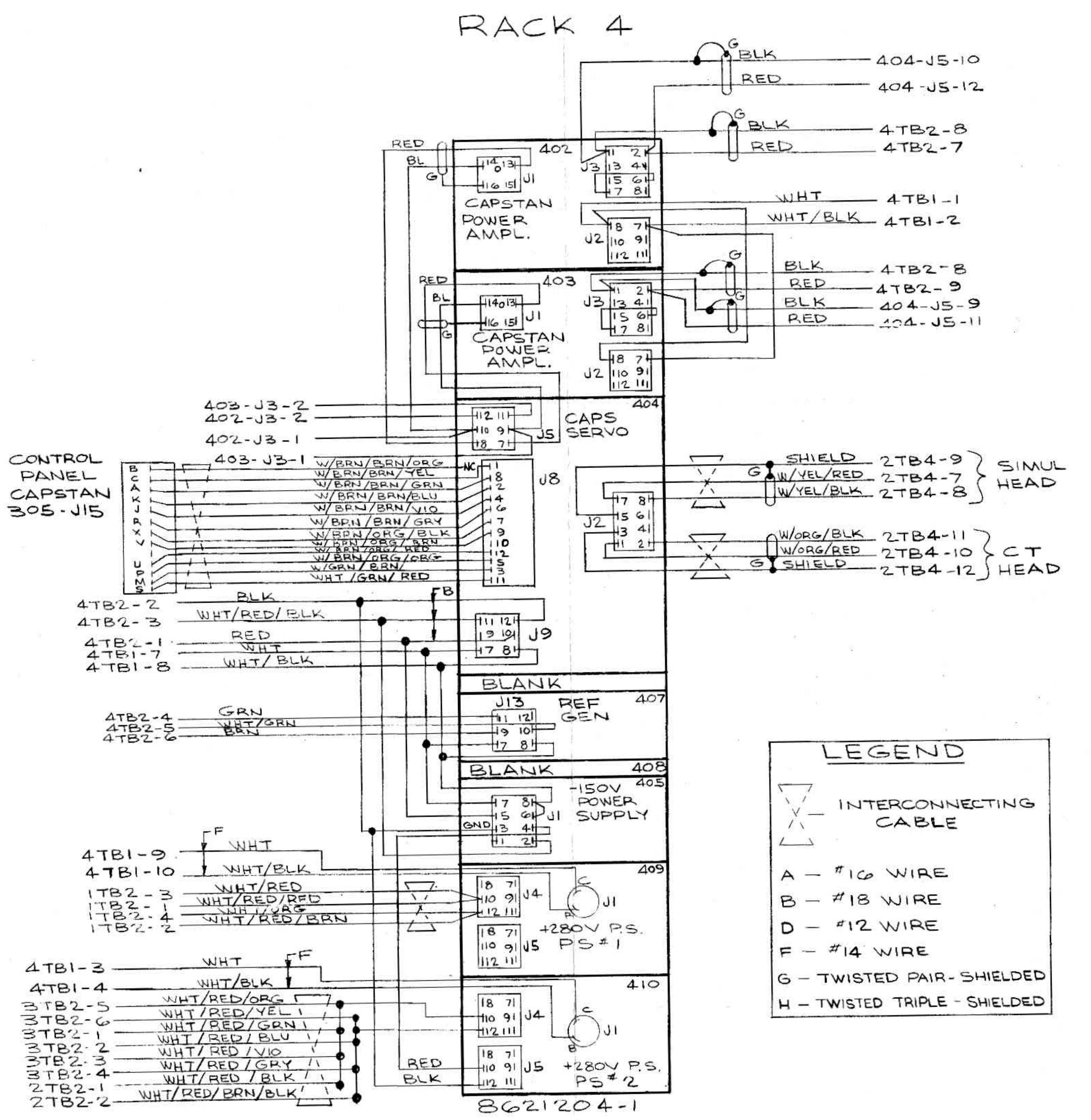


Figure S-20. 2 x 1 Switcher, Schematic Diagram

PARTS LIST

Symbol No.	Stock No.	Drawing No.	Description	
		RACK #4 (8975564-503)		13
4TB1, 4TB2		449691-5	Board: terminal	





Interconnection Diagram, Rack 4

ELECTRONIC RECORDING PRODUCTS

Servo Power Amplifier

UNITS 402, 403, 502, and 503

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
DU 6,61

IB-31147

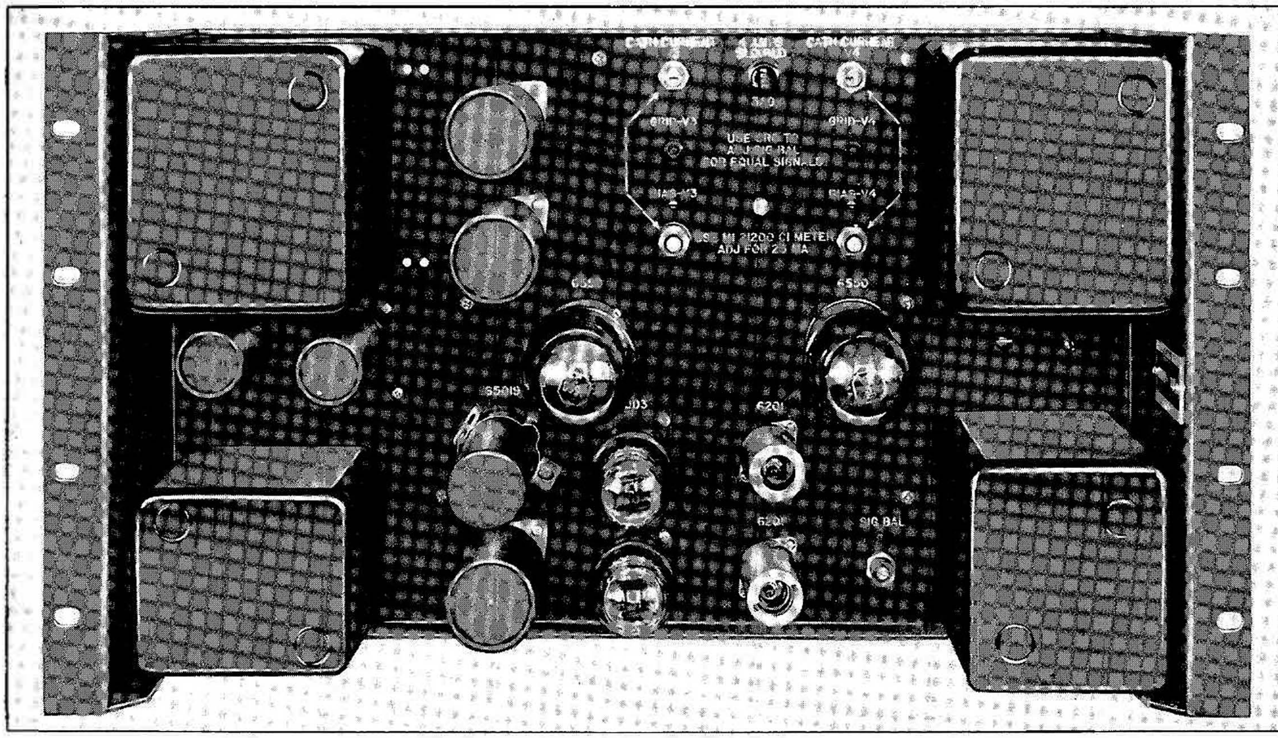


Figure SA-1. Servo Power Amplifier

TECHNICAL DATA

Power

Input: 117 volts, 50/60 cycles, 200 watts maximum. (Input power for Capstan Power Amplifiers is obtained from circuit breaker #2.) (Input power for Headwheel Power Amplifiers is obtained from circuit breaker #5.)

Output: 70 watts (maximum)

Frequency Response

40 to 2500 cycles

Input Impedance

470,000 ohms

Output Impedance

Capstan Servo: 136 ohms
Headwheel Servo: 72 ohms, C.T.

Tube and Rectifier Complement

(2) 6201	(1) 1N538
(2) 6550	(1) CR1 (Rectifier: Selenium)
(2) OD-3	(1) S5019 (Rectifier: Silicon)

DESCRIPTION

The Servo Power Amplifiers (figure SA-1) amplify the output signal of the capstan or headwheel servo unit and deliver the required power to drive the motors.

In the capstan servo system, two power amplifiers (units 402, 403) are used to supply the two-phase power to the capstan motor. In the headwheel servo system, two-phase power from two amplifiers (units 502, 503) is converted by a Scott transformer connection to three-phase power to drive the headwheel motor. Each amplifier has a self-contained power supply.

Circuit

Amplifier—The servo power amplifier (refer to the schematic diagram figure SA-5) is a four stage r-c coupled amplifier of controlled frequency response (40 to 2500 cps) having negative feedback and good regulation. The input signal from the servo unit is applied to the voltage amplifier stage V1A. Amplifier stage V1A is stabilized by the degenerative feedback resulting from the unbypassed cathode resistor R2. Stage V1B is a phase splitter that delivers out-of-phase signal voltages to stages V2A and V2B. Stages V2A and V2B amplify the signal to a level to drive the power amplifier stages V3 and V4 that are connected in push-pull. Balance potentiometer R10, connected between the grids of stages V2A and V2B, is used to balance the a-c signals applied to the power amplifier stages V3 and V4. The d-c operating points of tubes V3 and V4 are set by the bias adjustment potentiometers R28 and R29 in the grid circuits. The bias

potentiometers are adjusted to give 25 milliamperes of cathode current for each tube under quiescent conditions, i.e., with no input signal applied. Transformer T3 is driven in push-pull by the plates of tubes V3 and V4. The amplifier is stabilized by means of negative feedback through the network consisting of resistor R16 and capacitor C5 from the plate of tube V3 to the cathode of V2A. A similar feedback path exists between the plate of V4 and the cathode of V2B through R17 and capacitor C6.

Capstan Motor Connection—An internal jumper wire between pins 6 and 7 of cable plug P3, on each capstan power amplifier (units 401, 402), provides an output impedance of 136 ohms for each amplifier. This impedance is selected so that the correct voltages are obtained for driving the two phases of the capstan motor, while maintaining sufficiently low source impedance for good servo action. Power factor correction is obtained by placing a capacitor across each phase at the tape transport panel.

Headwheel Motor Connection — The conversion from 2-phase to 3-phase power for the headwheel motor is obtained by the use of the Scott transformer connection illustrated in figure SA-2; for this connection the 72Ω and C.T. windings are used. The amplitude of the voltage in the output circuit operating at the 90-degree phase position must be 86.6% of the voltage in the reference circuit. When one side of the 90-degree output transformer is connected to the center tap of the 0-degree transformer, as shown in figure SA-2A, the voltages between the three output leads are combined vectorially to produce the phase balanced voltages shown in the vector diagram figure SA-2B. A capacitor, located on the tape transport panel, across each phase corrects the power factor.

Power Supply—The amplifier has a self-contained power supply, this power supply consists of two sections: (1) a filament and bias supply using transformer T1; (2) an anode supply using transformer T2. The primary winding of each transformer has taps for operation from 109, 117, or 125 volts ac. The transformers are connected for 117 volt operation but can be changed if so desired. The transformers are protected from overload by a four ampere fuse in the common input line. The top secondary winding of transformer T1 provides 6.3 volts ac for the amplifier tube filaments. Grid bias for power amplifier tubes V3 and V4 is obtained by rectifying the output of the center secondary winding of transformer T1 with selenium rectifier CR1. The bottom secondary winding of transformer T1 is connected to terminals 4 and 6 of tube socket XV5; so that in case of an emergency, the silicon rectifier SR1 can be replaced temporarily by a 5R4GY tube but with some reduction in amplifier output power.

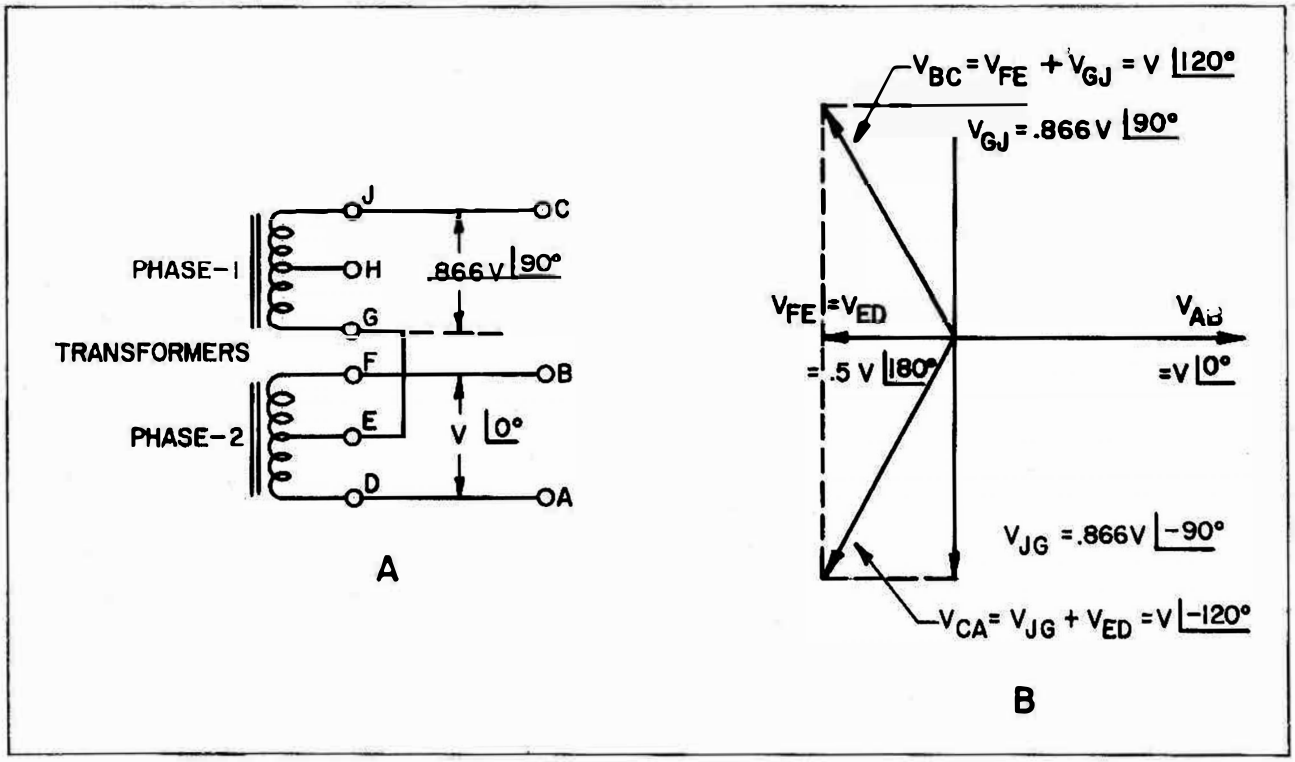


Figure SA-2. Scott Transformer Connection

The output voltage of the secondary winding of transformer T2 is rectified by a silicon rectifier SR1, filtered by a choke input filter, and applied to the plate and screen circuits of amplifiers V3 and V4. Two type OD-3 voltage regulator tubes, connected in series, are used to keep the screen voltages of the output tubes constant regardless of variations in signal strength and line voltage. An internal jumper in each regulator tube acts as an interlock to open the primary circuit of transformer T2 when either of the voltage regulator tubes is removed from its socket.

MAINTENANCE

The procedure used in the servicing of resistance-capacitance coupled amplifiers in general can be applied in the servicing of this amplifier.

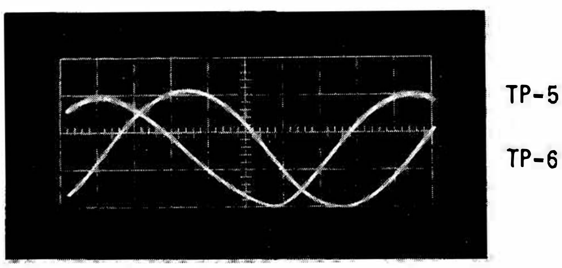
Setup Adjustments

To permit adjusting the power amplifiers the following equipment is required.

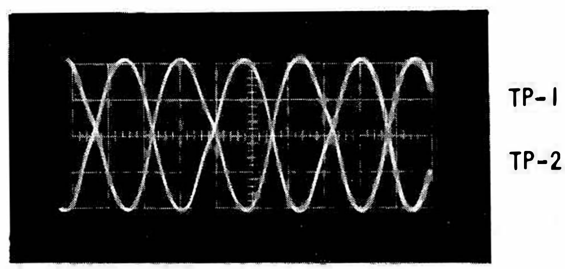
1. Tektronix Type 535 oscilloscope or equivalent.
2. Plug-in Milliammeter, RCA MI-21200-C1.

To set up the two capstan power amplifiers (units 402, 403) perform all the steps given in the table headed *Adjustments on Power Amplifiers.* On the two headwheel power amplifiers (units 502, 503) perform only the Bias Adjustments, step 2 to 4, and the Signal Balance Adjustments, steps 8 and 9. (The output amplitude adjustments for the headwheel amplifiers are included in the setup procedure for the headwheel servo chassis.)

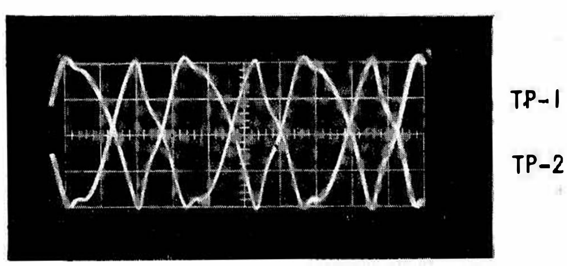
NOTE: The capstan power amplifiers must be adjusted before setting up the capstan servo chassis (unit 404). Similarly, the adjustments on the headwheel power amplifiers must be made before setting up the headwheel servo chassis (unit 504).



**A. PH-1 (TP-5), PH-2 (TP-6)
Capstan Servo Chassis (Unit 404)
Sweep Rate: 2000 μsec/cm
Amplitude: 100 volts/cm**



**B. Grid V3 (TP-1), Grid V4 (TP-2)
Upper Power Amplifier (Unit 402 or 502)
Sweep Rate: 5000 μsec/cm
Amplitude: 10 volts/cm**



**C. Grid V3 (TP-1), Grid V4 (TP-2)
Lower Power Amplifier (Unit 403 or 503)
Sweep Rate: 5000 μsec/cm
Amplitude: 10 volts/cm**

***Figure SA-3. Waveforms for Capstan Power Amplifier Adjustments
(Waveforms for Headwheel Power Amplifier are similar)***

ADJUSTMENTS ON POWER AMPLIFIERS

BIAS ADJUSTMENTS

Step No.	*Plug Milliammeter Into Jack*	*Procedure*
1		Press STOP button.
2	CATHODE CURRENT V3 (J4) on upper power amplifier.	Adjust BIAS V3 control, R29, for 25 ma.
3	CATHODE CURRENT V4 (J5) on upper power amplifier.	Adjust BIAS V4 control, R28, for 25 ma.
4		Repeat steps 2 and 3 on lower power amplifier.

OUTPUT AMPLITUDE ADJUSTMENTS (CAPSTAN SERVO CHASSIS, UNIT 404)**

Step No.	*See Fig. No.*	*Connect Scope To**	*Procedure*
5			Press SETUP button on control panel.
6	3A	PH-1 (TP-5).	Adjust AMPL PHASE 1 control, R112, for 320 v p-p (115 v rms).
7	3A	PH-2 (TP-6).	Adjust AMPL. PHASE 2 control, R113, for 320 v p-p (115 v rms).

SIGNAL BALANCE ADJUSTMENTS (MACHINE IN SETUP MODE)

8	3B	"A" input to GRID V3 (TP-1) on upper power amplifier. "B" input to GRID V4 (TP-2) on upper power amplifier.	Adjust SIG BAL control, R10, on upper power amplifier for equal (and opposite) signals at TP-1, 2.
9	3C	Same as step 8, but on lower power amplifier.	Repeat step 8 on lower power amplifier.

* Use internal sync on scope.

** STEPS 5, 6, 7 apply only when setting up capstan power amplifiers. Amplitude adjustments for headwheel power amplifiers are made during setup of headwheel servo chassis.

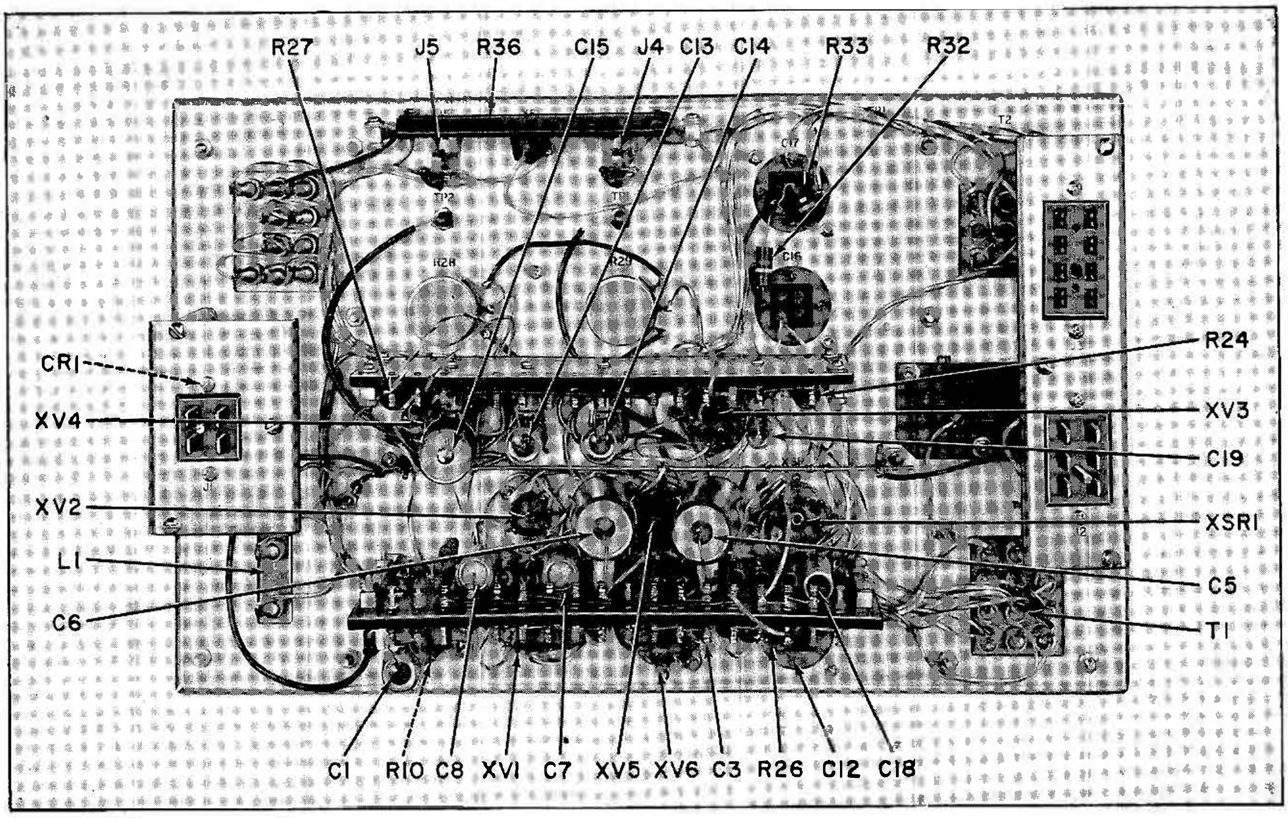


Figure SA-4. Servo Power Amplifier (Rear View)

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
POWER AMPLIFIER HEADWHEEL AND CAPSTAN SERVO (DWG. #8511039-501) 7			
			CAPACITORS:
C1	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C2 to C4	217265	737818-93	paper, 0.1 μf ±10%, 400 v
C5,C6	219919	8515252-1	paper, 0.47 μf ±10%, 1000 v
C7,C8	98982	737816-133	paper, 0.1 μf ±10%, 600 v
C9	208024	722024-513	mica, 1500 $\mu\mu$f ±5%, 500 v
C10,C11	59983	458557-29	electrolytic, 40 μf 450 v
C12	99123	458558-9	electrolytic, 80 μf 450 v
C13,C14	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C15	99323	8958264-55	electrolytic, 80 μf 150 v
C16,C17	99123	458558-9	electrolytic, 80 μf 450 v
C18		735715-271	paper, 0.047 μf ±10%, 600 v
C19	78145	8958264-46	electrolytic, 10 μf 150 v
C20		727866-241	mica, 560 $\mu\mu$f ±5%, 500 v char "B"
CR1	221881	149392-3	Rectifier: selenium
CR2	215443		Diode: type 1N538
F1	212231	990157-112	Fuse: 4 A 125 v
J1	52107	727969-13	Connector: male, 4 contacts
J2	51604	727969-3	Connector: male, 6 contacts
J3	56077	727969-5	Connector: female, 8 contacts
J4,J5	206074	818721-5	Connector: jack, telephone
L1	221882	8461411-1	Reactor: filter
P1	52108	727969-14	Connector: female, 4 contacts
P2	51607	727969-4	Connector: female, 6 contacts

Symbol No.	Stock No.	Drawing No.	Description
P3	58978	727969-6	Connector: male, 8 contacts
			RESISTORS,
			Fixed, Composition - unless otherwise specified
R1		82283-223	470,000 ohms, ±5%, ½ w
R2		90496-179	6800 ohms ±5%, 1 w
R3		90496-204	75,000 ohms ±5%, 1 w
R4		82283-215	220,000 ohms ±5%, ½ w
R5		90496-179	6800 ohms ±5%, 1 w
R6, R7	221888	990733-501	film, 100,000 ohms ±1%, 1 w
R8		82283-215	220,000 ohms, ±5%, ½ w
R9			Not Used
R10	97961	8971860-117	variable, 500,000 ohms, ±10%, 2 w
R11		82283-215	220,000 ohms, ±5%, ½ w
R12, R13	221887	990733-318	film, 1500 ohms ±1%, 1 w
R14, R15		99126-207	100,000 ohms, ±5%, 2 w
R16, R17	221889	990736-493	film, 90,900 ohms ±1%, 2 w
R18, R19		82283-201	56,000 ohms ±5%, ½ w
R20		82283-159	1000 ohms ±5%, ½ w
R21, R22	215410	990733-101	film, 10 ohms ±1%, 1 w
R23		99126-169	2700 ohms ±5%, 2 w
R24	59942	458572-93	wire wound, 30,000 ohms ±5%, 5 w
R25		99126-151	470 ohms ±5%, 2 w
R26	96214	458574-77	wire wound, 15,000 ohms ±5%, 10 w
R27	221886	458572-54	wire wound, 1250 ohms ±5%, 5 w
R28, R29	206071	737847-38	variable, 3800 ohms ±5%, 2 w
R30			Not Used
R31		99126-170	3000 ohms ±5%, 2 w
R32, R33		99126-211	150,000 ohms ±5%, 2 w
R34, R35		82283-183	10,000 ohms ±5%, ½ w
R36		993002-99	wire wound, 8000 ohms ±5%, 25 w
R37		99126-183	10,000 ohms ±5%, 2 w
R38, R39		90496-207	100,000 ohms ±5%, 1 w
R40, R41		82283-159	1000 ohms ±5%, ½ w
SR1	221213		Rectifier: silicon
T1	221883	8461412-1	Transformer: filament
T2	221884	8461413-1	Transformer: plate
T3	221885	8461414-1	Transformer: audio
TP1, TP2	205675	8825493-23	Jack: tip
V3, V4	210752		Tube: type 6550
XF1	48894	99088-2	Holder: fuse
XSR1	68590	99100-4	Socket: octal
XV1, XV2	94880	737870-18	Socket: tube, 9 pin
XV3 to XV6	68590	99100-4	Socket: tube, octal

VACUUM TUBE AND RECTIFIER VOLTAGE TABLE

Symbol	*Type*	*Pin Numbers*								
		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
V1	6201	220	55	68	*6.3	*6.3	225	—	5	*6.3
V2	6201	240	—	4	*6.3	*6.3	240	—	4	*6.3
V3	6550	0	*6.3	605	300	—37	—37	*6.3	0	—
V4	6550	0	*6.3	605	300	—35	—35	*6.3	0	—
V5	OD-3	N.C.	146	—	N.C.	—290	N.C.	—	N.C.	N.C.
V6	OD-3	N.C.	0	—	N.C.	146	N.C.	—	N.C.	N.C.
SR1		N.C.	610	N.C.	*710	N.C.	*710	N.C.	610	—

* All voltages preceded by an asterisk are ac. The voltage measurements were taken with a VTVM and have chassis ground as a reference.

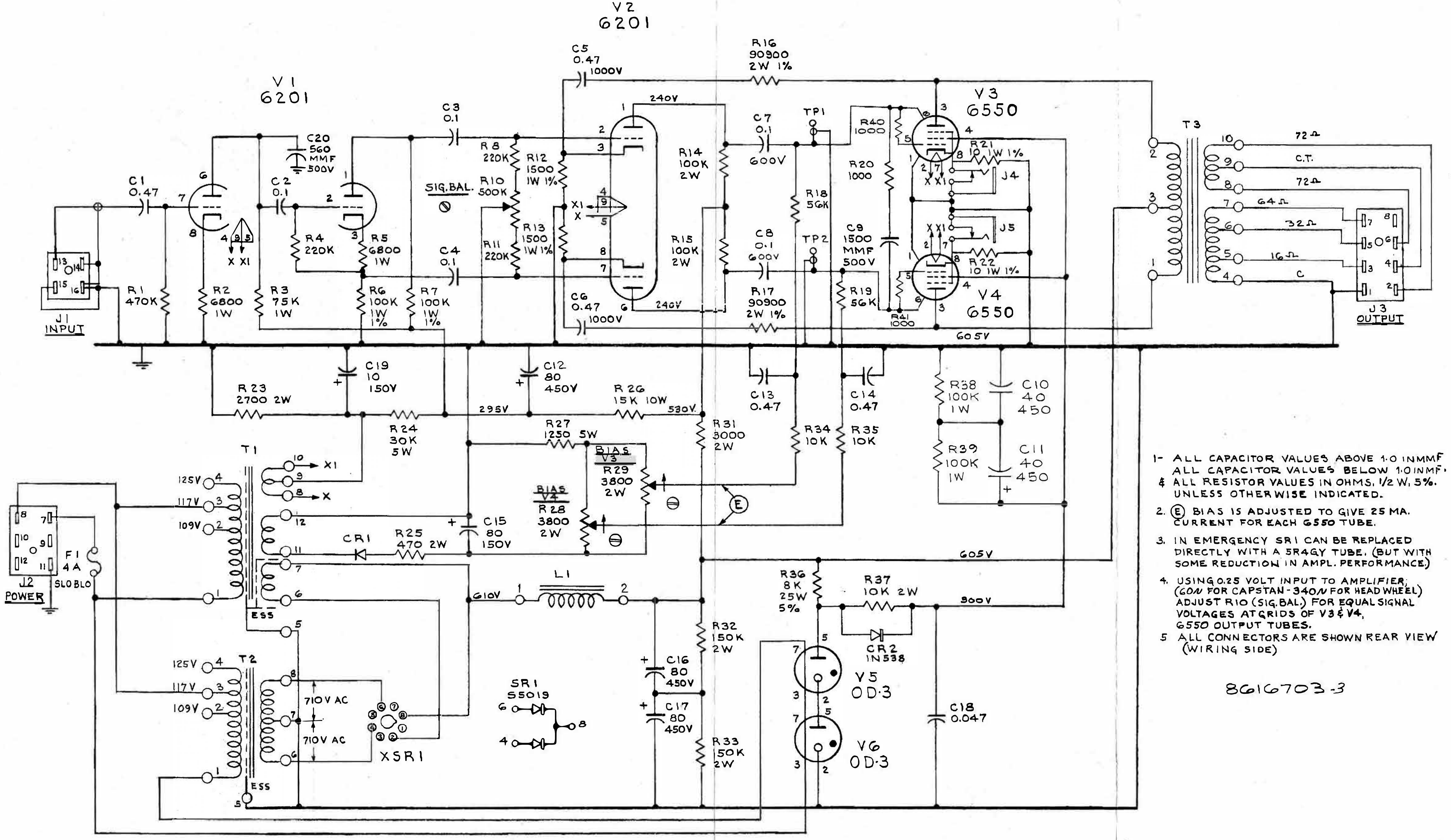


Figure SA-5. Servo Power Amplifier Schematic Diagram

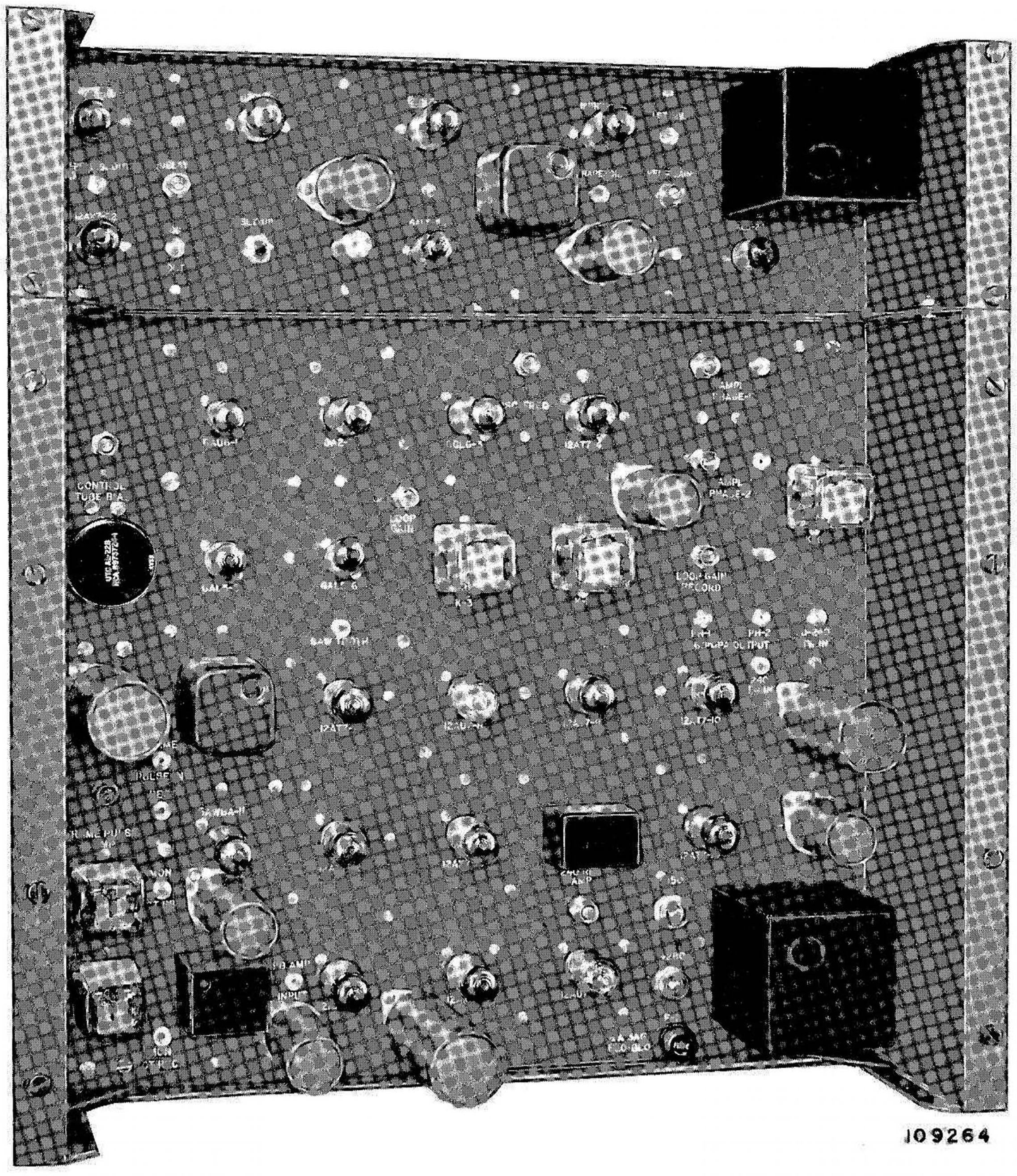
Capstan Servo

UNIT 404

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 671

IB-31148



J09264

Figure CS-1. Capstan Servo Chassis

TECHNICAL DATA

Power Required

Filament Transformer: 117 volts, 50/60 cps, 60 watts (from circuit breaker No. 4)

Plate: 280 volts dc, 117 ma (from unit 410, interlocked with —150 volt supply)
—150 volts dc, 62 ma (from unit 405)

Relays: 24 volts dc (from Control Panel)

Input Signals

Tape Signals

From C.T. Playback/Record head

From C.T. Simultaneous playback head (Record only)

Timing Signals

Frame Pulse, 4 volts peak-to-peak, 75 ohm input impedance

Tonewheel 240 cps, 4 volts peak-to-peak, high impedance bridging

Delayed 240 cps tonewheel, 4 volts peak-to-peak, 75 ohm input impedance

Output Signals

2 phase 60 cps to power amplifiers (units 402 and 403)

Monitoring Signals

(a) C.T. playback signal
(b) C.T. record signal
(c) Sawtooth lock signal
(d) DC current for control track record current meter on control panel.

Tube Complement

1	0A2	2	6201
1	6CL6	4	12AX7
1	6AU6	6	12AT7
1	6AW8	2	12AU7
4	6AL5	2	12BH7

DESCRIPTION

The Capstan Servo (see figure CS-1) provides a 60-cycle, two-phase, controlled drive to the capstan motor, which in turn controls the speed at which the tape is pulled through the machine. The heart of this controlling system is an fm modulated 60-cps oscillator (see figure CS-2).

During record, the 60-cycle oscillator frequency is controlled by a phase comparison of its frequency with a 240-cycle tonewheel signal derived from the speed of the headwheel motor. During record, a 240-cycle control track (C.T.) signal, derived from the headwheel (HW) speed, is recorded on the tape by a C.T. head for reference when in playback.

During playback (PB), this 240-cycle C.T. signal is phase compared to a 240-cycle signal derived from the HW motor, for control of the oscillator. Thus, the PB speed is controlled by the speed of the HW motor and the C.T. signal from the tape. This locking action insures the tracking of the video heads over the recorded video tracks on the tape. Also during playback, a velocity loop is used in conjunction with the phase loop to increase the locking range of the oscillator on the initial lock-up at the start of operation.

The capstan servo chassis also includes the circuits for recording, monitoring, and playing back 240-cycle and 30-cycle frame-pulse information from the control track. The 30-cycle frame-pulse is used for splicing.

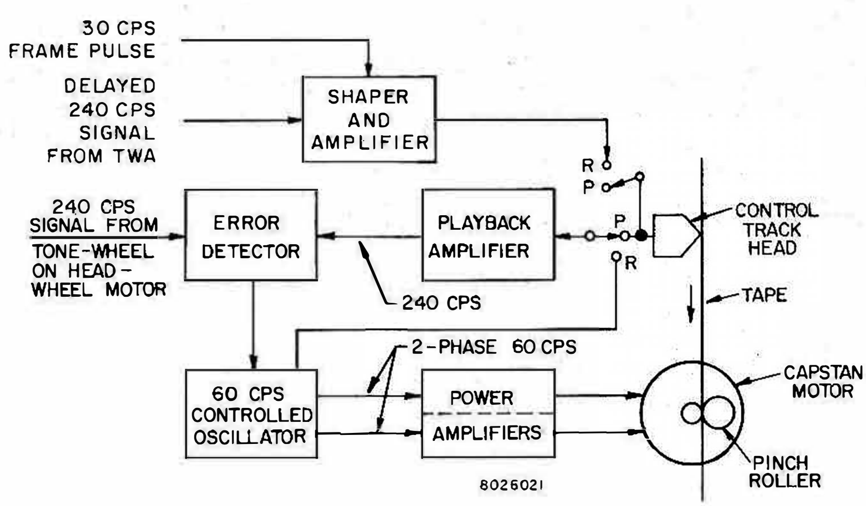


Figure CS-2. Simplified Block Diagram of Capstan Servo System

Functional

A block diagram of the capstan servo is shown in figure CS-3. The 240-cycle delayed output tonewheel pulse is applied to a filter circuit which converts it to a 240-cycle sine wave. The 240-cycle sine wave is combined with a 30 cps frame pulse and applied to the control track head through the recording amplifier. The 30 cps frame pulse is generated in the reference generator (unit 407) and is used primarily to identify the proper cutting point in tape splicing operation.

Provision is made for monitoring the current through the control track head, both with a waveform monitor and with a meter mounted on the main control panel. To make doubly sure that the control track is recorded properly, a simultaneous playback head is mounted on the tape transport panel. The pickup of the simultaneous playback head is fed through an amplifier to the CRO monitor switcher (unit 307) where it can be displayed on the CRO waveform monitor.

The simultaneous playback head is used only in the record mode. The same head that is used for recording information on the control track is used for playback to preserve the original time relationships in the signals, and minimize the length of tape between the video headwheel and the control track head.

In the record mode, the 240-cycle tonewheel pulse, generated by the speed of the headwheel motor, is coupled to the 2-stage phase shifter. After the phase shifter, this pulse is used to generate a sawtooth which drives the phase detecting bridge.

The other input to the bridge is a pulse derived from the output of the 60 cps oscillator after passing through

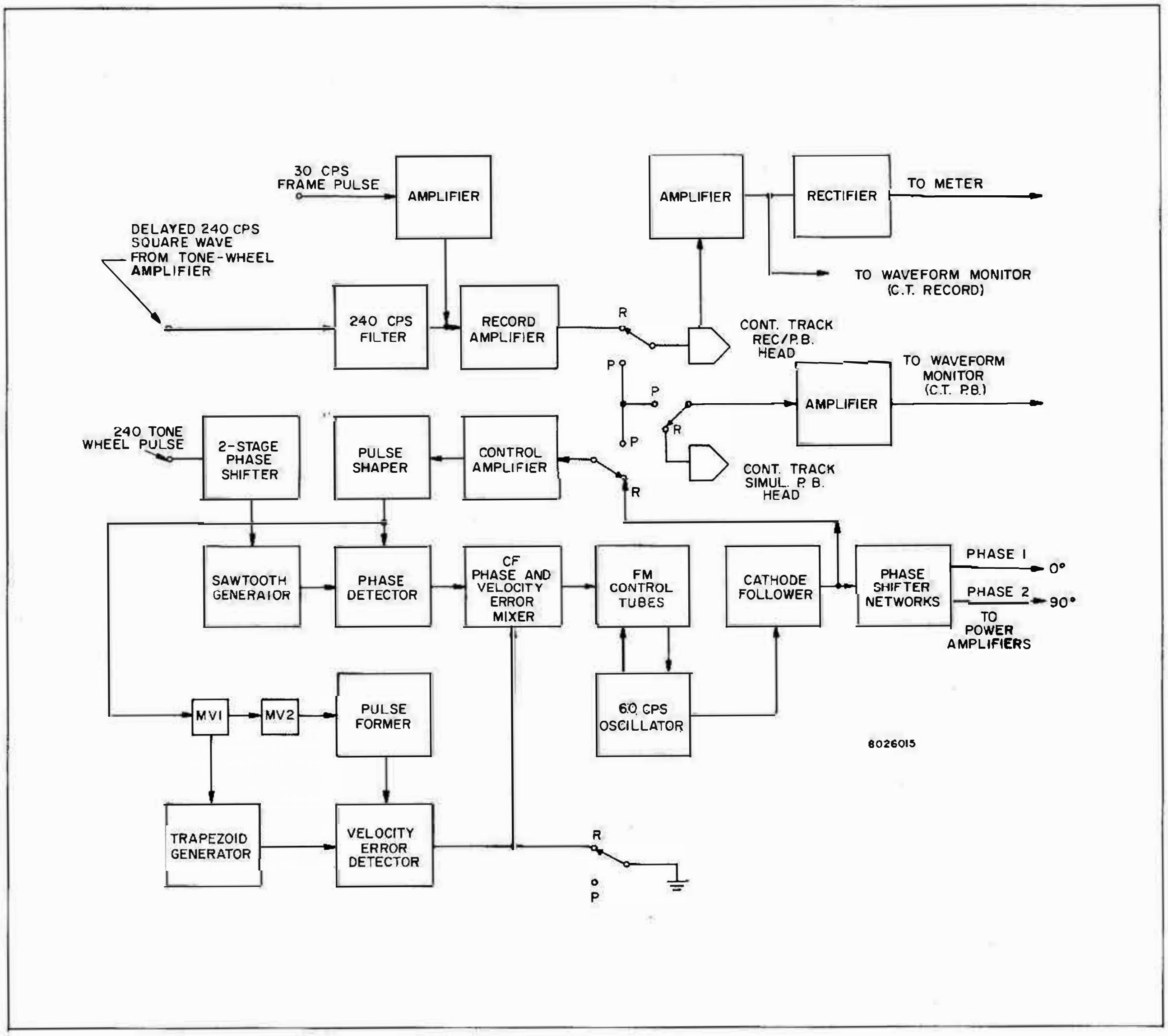


Figure CS-3. Block Diagram, Capstan Servo Chassis

a control amplifier and pulse shaper. The dc error from the bridge output feeds the control tube which controls the oscillator frequency. In the record mode, the velocity error detector is not needed and therefore is shorted out by a relay contact. In the playback mode, the 240 cps sine wave which is picked up from the control track, is converted into a sampling pulse, and fed to phase detectors where it is compared with a sawtooth generated from the tonewheel signal and the velocity error detector. The tonewheel signal is passed through a wide-range phase shifter which provides a manual adjustment for centering any of the four video heads over any desired track on the recorded tape.

The outputs of the phase and velocity detectors are applied to a phase and velocity error mixer. The output of this mixer is fed to a control tube which modifies the frequency of a 60-cps oscillator just enough to keep the tape traveling at the proper speed, and maintaining proper phase relationship of the control track signal to the tonewheel signal.

Since there are several different circuits in the capstan servo, each circuit explanation will be aided with a simplified circuit diagram. On each simplified diagram, there is a table which cross references various points in the circuit with waveforms shown in the Maintenance section.

Control Track Circuits

The circuits for record, playing back, and monitoring the control track are illustrated in figure CS-4. During record, the delayed 240-cps tonewheel square wave is converted to a sine wave by a "packaged" 240-cps filter, and mixed with the frame pulse signal by a resistance mixing network at the grid of V11B. The

TABLE FOR FIGURE CS-4

Symbol	*Pin Number*	*Reference to Figure Waveform*
V11	1	CS-13C
	3	CS-13D
	7	CS-13G
	9	CS-13H
V15	1	CS-16B, CS-18C
	2	CS-16A, CS-18B
V17	1	CS-13K
	6	CS-13J
	7	CS-13I
	8	CS-13L
FILTER IN	—	CS-13E
FILTER OUT	—	CS-13F
TP9	—	Same as V17 pin 7
TP10	—	CS-16D, E and F; CS-18D
TP12	—	CS-18B, CS-16A

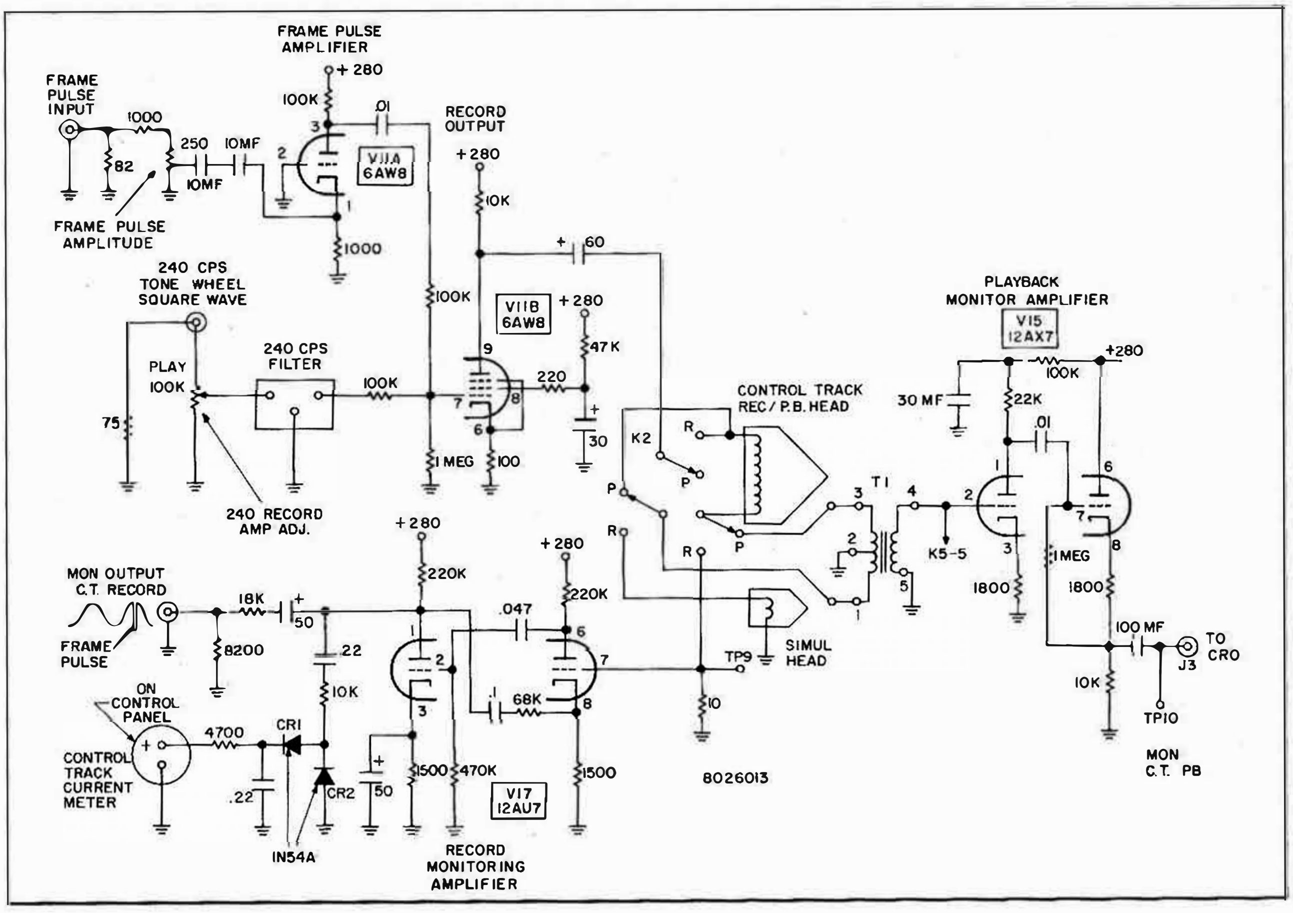


Figure CS-4. Control Track Recording and Monitoring Circuits

frame pulse (J1) from the Reference Generator passes through gain control R50 before driving the cathode of V11A. Cathode drive is used to obtain the correct phasing of the frame pulse with respect to the control track phase.

Tube V11B is the driving amplifier for the control track recording head. A 10-ohm current sampling resistor is connected in series with the control track head and ground. The signal across this resistor is amplified by V17, a dual-triode feedback amplifier. The output of V17 is directed both to the CRO waveform monitor unit 306, (through an 18K isolating resistor) and to a rectifier which drives the control track current meter on the main control panel. Also during record, relay K2 allows the pickup of the simultaneous playhead to be fed to the monitor amplifier so that whatever is being recorded, may be viewed immediately on the CRO waveform monitor.

During playback, relay K2 opens the circuit between the output of V11B and the record playback head. The record playback head then feeds its output through T1 and the monitor amplifier (V15) where the control track playback signal is amplified and fed to the monitor switcher (unit 307) where it can be displayed on the CRO waveform monitor.

Control Signal Amplifiers

Figure CS-5 shows the control signal amplifiers. In the record mode, the simultaneous playback head is connected to the input transformer (T1); but in the playback mode, the main control track record — playback head is connected to T1. However, regardless of which signal is being passed through T1, it is amplified by V15 before going to the CRO waveform monitor. The monitor amplifier, V15, consists of a voltage-gain stage (V15A) followed by a cathode follower (V15B).

Tube V16 is a feedback-pair amplifier. The feedback path consists of a twin-T network. This network presents a high impedance at 240 cps, so the negative feedback at this frequency is relatively low and the gain is correspondingly high. At higher and lower frequencies, the feedback is considerably greater, and the gain is greatly reduced. The net result is that the signal delivered to the following stages is a reasonably pure sine wave.

TABLE FOR FIGURE CS-5

Symbol	*Pin Number*	*Reference to Figure Waveform*
V15	1	CS-16B, CS-18C
	2	CS-16A, CS-18B
V16	1	CS-14B, CS-18E
	2	CS-14A, CS-18B
	3	CS-14C
	6	CS-14D, CS-18F

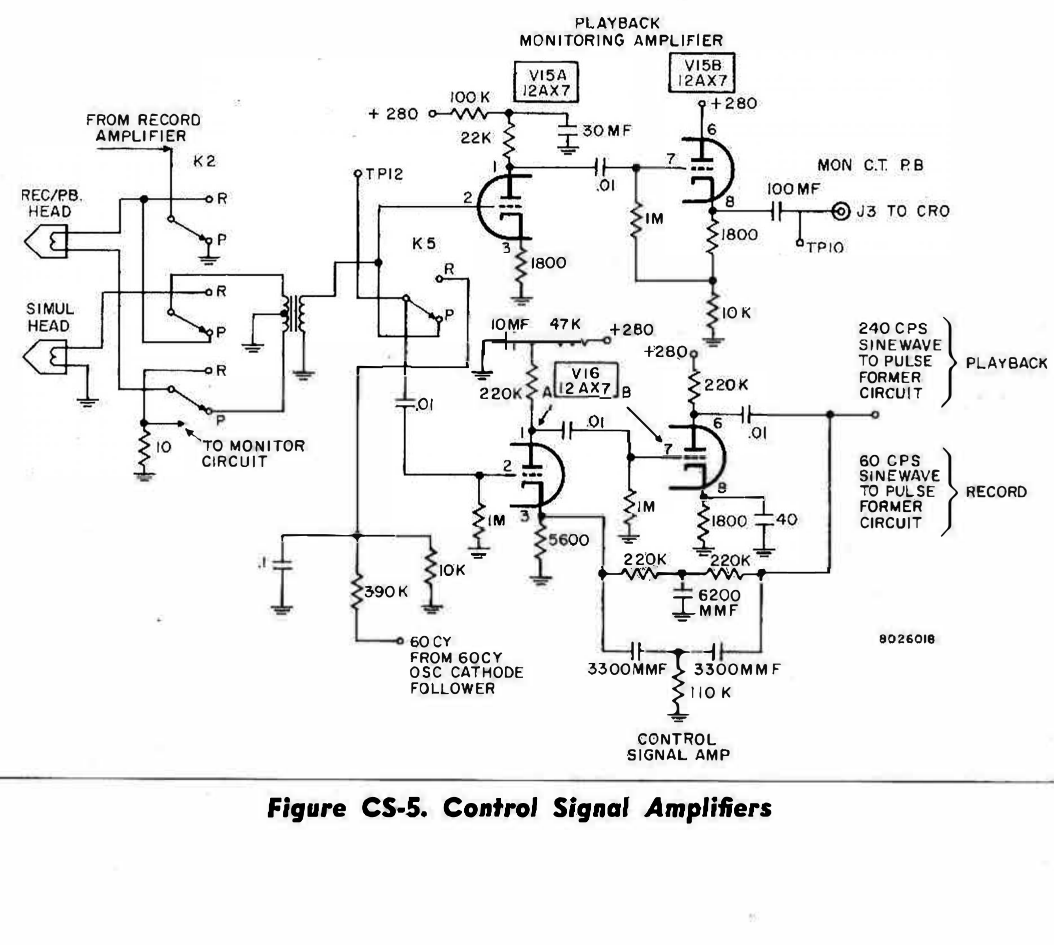


Figure CS-5. Control Signal Amplifiers

In the record mode, the control amplifier V16, receives a signal from the 60-cycle oscillator. Although this amplifier acts as a 240-cycle band-pass filter, the cut off is not as sharp at the lower frequencies and thus provides a sufficient amount of 60-cycle signal for the error detector circuits.

Pulse Forming Circuit

The 240 or 60 cps sine-wave from the control track playback amplifier is amplified by V12B, then further amplified and clipped by V13 (see figure CS-6). The latter stage is a cathode coupled circuit which provides amplification without a phase inversion. The signal at the plate of the right side of V13 is essentially a square wave, which is differentiated by C13 and R27. The positive "pip" resulting from this differentiation is suppressed by grid limiting in V12A, but the negative "pip" drives V12A toward cutoff and produces a sharp

TABLE FOR FIGURE CS-6

Symbol	*Pin Number*	*Reference to Figure Waveform*
V7B	1	CS-14J, CS-18L
V12	1	CS-14I, CS-18K
	2	CS-14H, CS-18J
	6	CS-14E, CS-18G
V13	3	CS-14F, CS-18H
	6	CS-14G, CS-18I

positive pulse in the plate circuit. The next stage, V7B, is normally biased below cutoff, but the peaks of the positive pulses from V12A turn V7B on to provide a keying pulse for the phase error detector and a trigger for the first M.V. in the velocity loop.

240-cps Phase Shifter and Sawtooth Generator Circuits

Before the 240-cps signal from the control track on PB (or 60-cycle PB output on record) is compared with the 240-cps signal from the tonewheel, which is attached to the headwheel motor, the latter signal is adjusted in phase and converted to a sawtooth waveform (see figure CS-7). An adjustable phase shift of slightly more than one full cycle at 240 cps is required to make it possible to center any of the four video heads over any given recorded track on the tape. Such flexibility in track head combinations makes it possible to adjust the machine for nearly uniform signal levels in all head channels on interchangeable tapes.

The tonewheel pulse amplifier, V9A, amplifies the signal used to trigger the first MV in the phasing circuit. The required wide range of phase shift is accomplished by two stabilized multivibrators in series, V10 and V14. The 240-cps tonewheel square wave from V9A is differentiated by a 220 $\mu\mu f$ capacitor (C42) and a 47K resistor (R84) to form positive and negative pips at the edges of the square wave. Diodes CR6 and

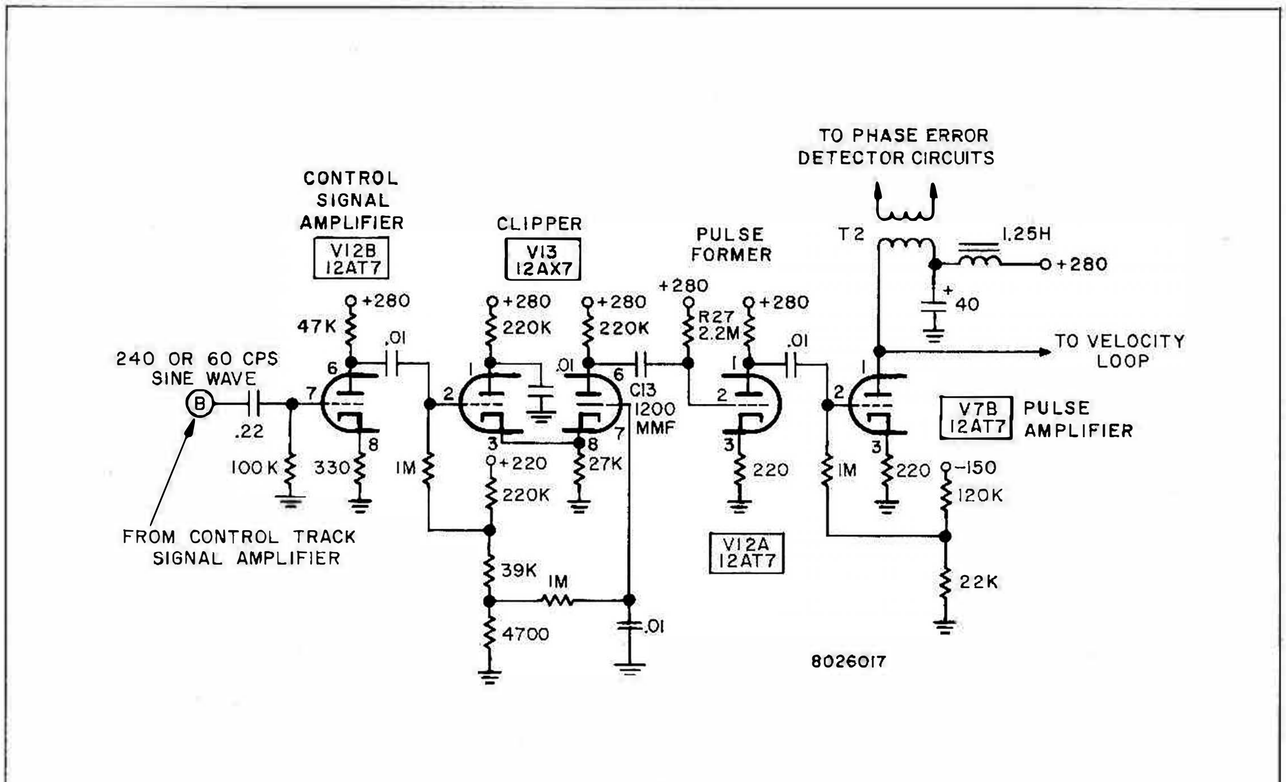


Figure CS-6. Pulse Former Circuit

CR5 permit only the negative pips to pass to the one shot multivibrator V10. Tube V14 is an identical multivibrator triggered by the trailing edge of the pulse produced in V10, by means of the differentiator and diode coupling network attached to the stabilizing diode in the cathode circuit of the right side of V10.

In both multivibrators, the B side conducts when the circuit is in the "resting" condition, but is driven below cut-off when a negative trigger is applied to the grid of the B side. The length of time the B side remains cut-off, which is the pulse period, is determined both by the time constant in the grid circuit (820 $\mu\mu$f capacitor and 1.5 meg resistor) and by the voltage range available to alter the charge on the coupling capacitor. The time constants of both V10 and V14 are fixed, but a control is provided to adjust the absolute voltage on the grids of both stages. This control which is marked CONTROL TRACK PHASE, is on the main control panel.

The output pulse at the cathode of V14 is differentiated by the 220-mmf capacitor, (C44) and 100K resistor (R91) in the grid circuit of V9B. The positive "pip" is suppressed by grid clipping; when V9B is driven positive, it draws grid current and attenuates the signal by the action of the 1000-ohm grid resistor, R90, in series with the relatively low grid-to-cathode impedance. The negative pulse in the plate circuit of V9B is clipped by diode CR3 and the positive pulse is used as a discharge pulse for the sawtooth generator, V8.

TABLE FOR FIGURE CS-7

Symbol	*Pin Number*	*Reference to Figure Waveform*
V8	3	CS-18A
	6	CS-17L
	7	CS-17K
V9	1	CS-16I
	6	CS-17J
	7	CS-17H or I
V10	1	CS-16L
	2	CS-17D
	6	CS-16J, K
	8	CS-17A
V14	1	CS-17C
	2	CS-17E
	6	CS-17B
	8	CS-17F

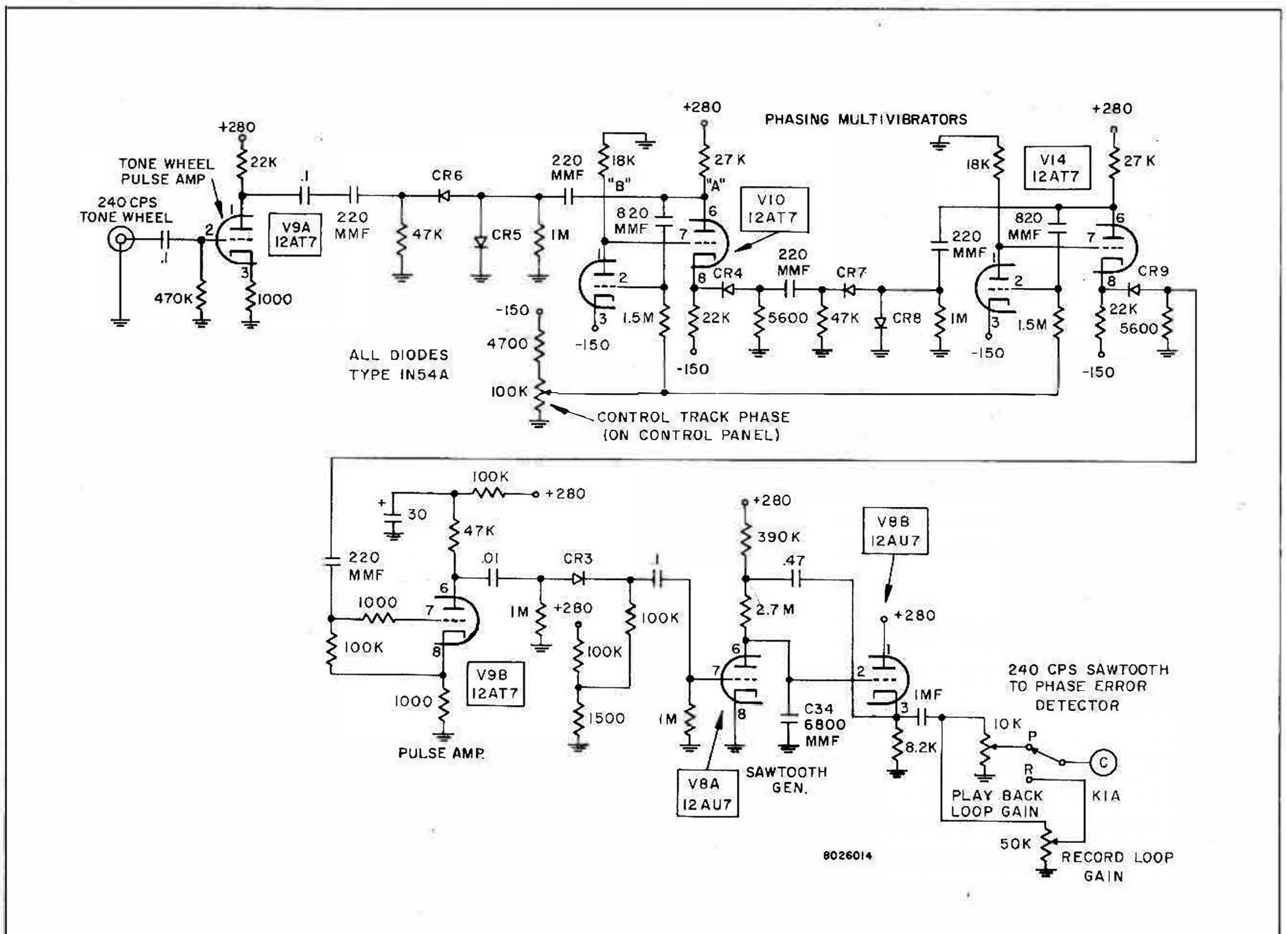


Figure CS-7. 240 CPS Phase Shifter and Sawtooth Generator

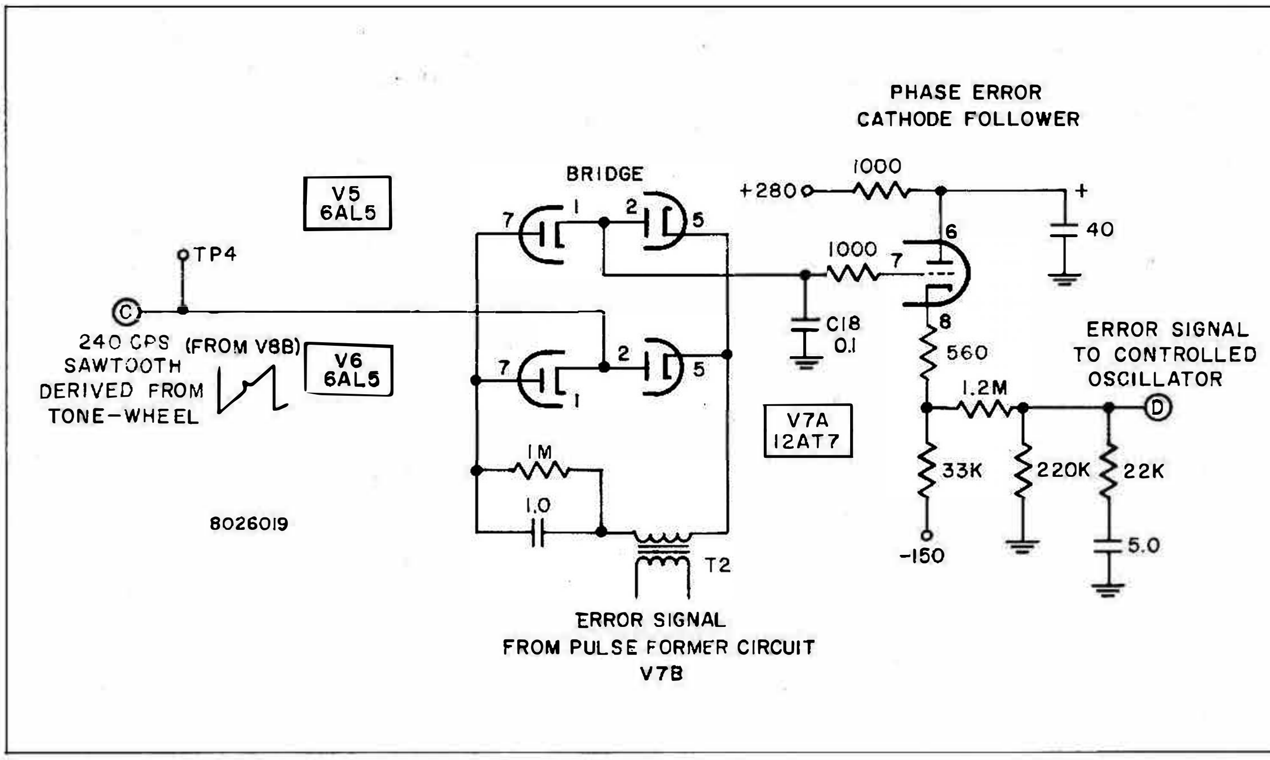


Figure CS-8. Phase Error Detector

The sawtooth generator is a "bootstrap" type. During the intervals between pulses, the 6800-mmf capacitor, C34, tends to charge up toward +280 volts at a rate determined by the 2.7-meg and 390K resistors (R66 and R65 respectively). From cathode follower, V8B, the rising voltage is coupled back to the positive end of the 2.7-megohm resistor through a large (0.47 mf) coupling capacitor C95. This rising voltage applied to the top of the current-limiting resistor tends to make the voltage drop across it uniform, throughout the sawtooth period, resulting in a highly linear sawtooth waveform across the 6800-mmf capacitor. When a positive pulse is applied to the grid of V8A, the storage capacitor is rapidly discharged through the tube, and a new sawtooth cycle begins. The output from V8B is coupled to potentiometers R127 and R34 which serve as the gain controls for the servo loop in record and playback.

Phase Error Detector

The phase detector uses two double diodes (V5 and V6) in a bridge-type circuit (see figure CS-8). The diodes are non-conducting except for brief intervals at the tips of the sampling pulses delivered by T2. The 1.0-mf capacitor, C17, in series with the secondary of T2 maintains its charge between pulses (except for the relatively slow discharge through the 1-megohm resistor R37) to keep the diodes in a non-conductive state between sampling instants. When the diodes are

TABLE FOR FIGURE CS-8

Symbol	*Pin Number*	*Reference to Figure Waveform*
V5	1, 2	CS-15A, CS-19D
V5, V7	5	CS-14K, CS-19B
V5, V7	7	CS-14L, CS-19C

closed, capacitor C18 is connected through the relatively low diode impedance to the LOOP GAIN potentiometer where the tonewheel sawtooth signal is present. During these sampling instants, capacitor C18 tends to charge up to whatever voltage is provided by the sawtooth. The proper sampling point is near the center of the long slope on the sawtooth. If the sampling pulses occur too fast, implying that the tape is being pulled too fast, the sampling pulses will move downward along the slope, thereby reducing the voltage across C18. Likewise, if the sampling pulses occur too slow, relative to the sawtooth, the voltage across C18 will increase because the sampling will occur at a higher point on the sawtooth. The sampling point can be observed by connecting an oscilloscope at test point TP4, (see figure CS-8) because a slight transient is visible on the sawtooth waveform due to feed thru.

The voltage across C18 is applied to a cathode follower, V7A, whose output circuit includes an attenuator to provide a proper level for the 60-cps controlled

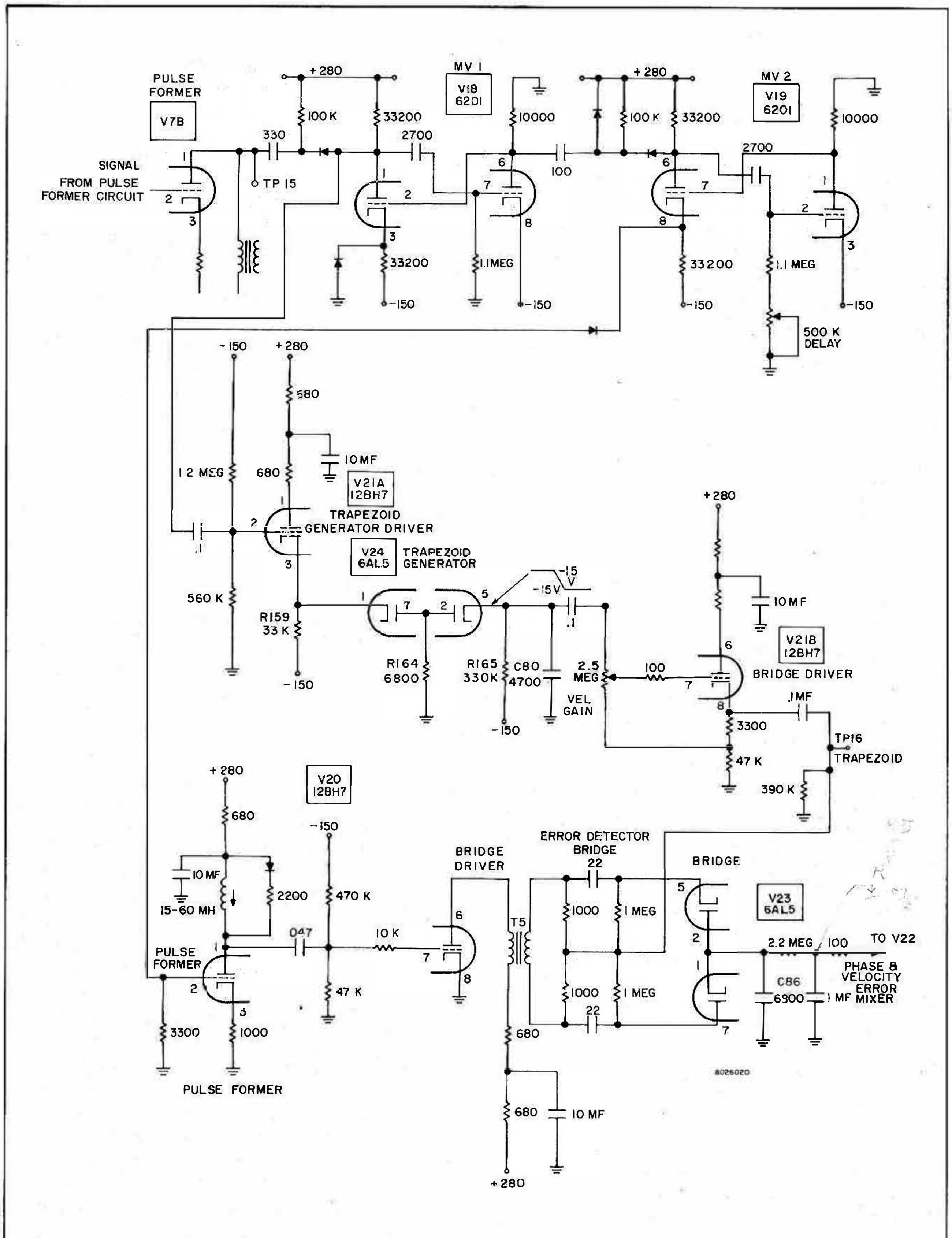


Figure CS-9. Velocity Loop Circuits

oscillator. The 22K resistor R39 and 5.0-mf capacitor C19 reduce the gain of the system for all except very low frequencies, and modify the phase-shift characteristic to minimize the risk of oscillation or hunting. During record, the transient will appear on every fourth sawtooth and during playback it will appear on every sawtooth.

Velocity Error Detector

The function of the velocity error detector (see figure CS-9) is to sense an error in the velocity of the tape as it passes through the machine and pass this error information to the controlled oscillator for a correction in the frequency which in turn compensates for incorrect speed. In practice this only affects the oscillator and speed of the tape during the lock-up period; the phase error detector then determines the phase and thus the speed during normal operation. Use of a velocity loop increases the reliability of lock-up by increasing the frequency range of the oscillator over which lock-up can be obtained. The circuit in which the tape speed is detected is shown in figure CS-9. During the following explanation of the velocity error detector, refer also to the block diagram figure CS-3 and the timing diagram of figure CS-10.

The output of the pulse forming circuit (see figure CS-3) triggers MV-1. The trapezoid is formed from the negative portion of the pulse from MV-1. Immediately preceding the triggering of MV-1 the grid of V21A is fed a positive signal from V-18, resulting in the conduction of V21A and, as a result, a positive voltage on the cathode of the diode V24A. This cuts off the diode V24A. The second half of V24 continues to conduct. The voltage at the cathode and plate of V24B is approximately −1.5 volt because of the voltage division of R-164 (6800 ohms) and R-165 (330K); C80 is also being charged to this −1.5 volt.

When V-18 is triggered by the tape signal, the plate goes negative and drives the grid of V21A negative, and as a result cuts off V21A. With V21A cut off, the diode V24A begins to conduct as its cathode is no longer positive. Because R159 is much smaller than R165, sufficient current is drawn through R164 from diode V24A and R159, so that the plate of V24B becomes negative (−15V) with respect to the −1.5V charge across C80 (4700 mmf) cutting off V24B. With V24B cut off, the capacitor C80 begins to discharge toward a −150V through R165 (330K). When the capacitor C80 reaches the voltage of the plate of V24B (−15V), the diode begins to conduct and the voltage is held there at −15V by the conduction of V24A. When the multivibrator action of V18 results in a positive signal at the grid of V21A, diode V24 is cut off and C80 rapidly discharges through R164 to the −1.5V of the voltage divider R164 and R165.

The trailing edge of the pulse from MV-1 triggers MV-2 (see figure CS-9). The period of time from the triggering of MV-1 and the trailing edge of the pulse from MV-2 is fixed by the design of these two multivibrators and is thus independent of the rate of triggering. When set correctly by the "Delay" adjustment (R177) the period of the two multivibrators is such that the pulse formed by the trailing edge of the second multivibrator is timed to coincide with the center of the trapezoid when the tape is running at the correct speed (tape pulses at a 240 cps rate). Refer to figure CS-10. Any deviation from this speed results in the pulses

TABLE FOR FIGURE CS-9

Symbol	*Pin Number*	*Reference to Figure Waveform*
V7B	1	CS-14J
V20	1 2 6	CS-20H CS-20G CS-20I
V21	3 7	CS-20B CS-20E
V23	1 5 7	CS-20L CS-20J CS-20K
V24	2 5	CS-20C CS-20D
V18	3 6 7	CS-19F CS-19H CS-19G
V19	1 2 6 8	CS-19K CS-19L CS-19J CS-20A

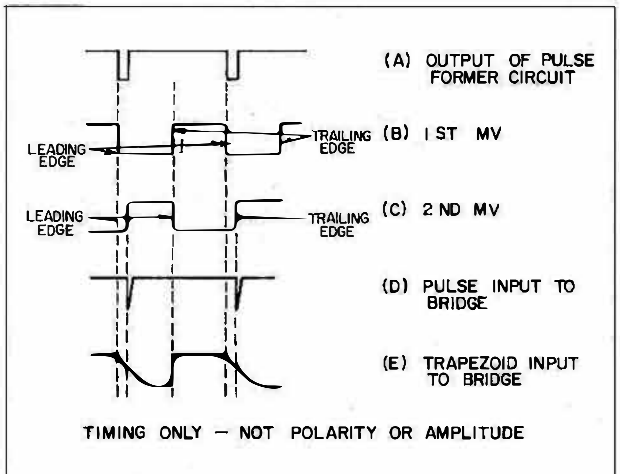


Figure CS-10. Velocity Loop Timing Diagram

from the multivibrators appearing at a time to place them high or low on the trapezoid. The pulses are formed in the ringing circuit of V20A by the negative going edge of the signal from V19. These pulses are fed to a detector stage through V20B, and T5. The two diodes, V23, are normally non-conducting except during the brief sampling intervals corresponding to the peaks of the pulses delivered by transformer T5. During sampling (or clamping) intervals, the charge on C86 is adjusted to make the output voltage equivalent to the trapezoid voltage at that instant. The voltage across the 6800 mmf capacitor remains constant between clamping intervals because when the diodes are open, the charge on the capacitor can be altered only through high impedance leakage paths. The signal applied to the center-tap of the clamper network is the 240 cps trapezoid waveform. The output of the clamp circuit is fed through a low frequency roll-off circuit to the tube V22 which combines the phase and velocity information and then applies it to the control tube in the oscillator circuit.

Controlled Oscillator

The controlled oscillator used in the Capstan Servo System is the phase shift type. In any oscillator there must be some form of positive feedback, some form of frequency selectivity, and enough gain to overcome the losses in the circuit (that is, the gain around the feedback loop must be greater than unity at the frequency of oscillation). In the phase shift oscillator, feedback from plate to grid of a single stage is provided through a multi-section network which introduces a 180-degree phase shift at the desired frequency of oscillation. (Direct feedback from plate to grid would be negative, but the 180-degree phase shift makes the feedback positive.) In the case of the capstan servo, the phase-shift type of oscillator was chosen primarily because it is readily adaptable to both manual and automatic frequency control. Refer to figure CS-11 of this instruction book.

The first section of the 3-section phase-shift network (of oscillator V4A) includes an adjustable resistor (OSC FREQ — R103) which provides a setup adjustment of the oscillator's frequency by affecting the phase shift of the first section. A relatively wide-range control (CAPSTAN SPEED, located on the main control panel) is provided for MANUAL OPERATION; this permits the speed of the tape to be varied enough to bring two machines into audio synchronism when they are playing back identical programs.

For automatic (or servo-controlled) operation, the limited-range manual control, R103, is provided to set the free-running frequency of the oscillator at the proper value which will permit the error detector to work in the middle of the sawtooth slope. The wide-range manual control is located on the machine's main control panel, and the relay which switches between manual and automatic operation is actuated by pushing in on the manual speed control knob. (The same relay also shorts out the error signal to completely disable the automatic control when manual operation is desired.)

The resistance in the second section of the phase-shift network consists of a 165K resistor, R99, in series with the output of cathode follower V3. A sample of the signal at the top of the 165K resistor is applied to the grid of V1 through a voltage divider consisting in part of a 3.3-megohm and a 220K resistor (R96 and R95). This signal is amplified by V1 and applied to cathode follower V3 with a phase inversion.

Capacitor C47 serves primarily to compensate for the phase shift introduced by the inter-stage coupling network between V1 and V3. Capacitor C46 blocks d-c between the cathode of V3 and the grid of V1. Because the signal applied by the cathode follower in series with the bottom end of R99 is out-of-phase in relation to the signal at its top end, the apparent resistance in this section of the phase-shifting network is somewhat less than the actual value. The amount of this apparent reduction is determined by the gain of the combination of V1 and V3. Since the grid of V1 is returned to the source of the error signal, developed by comparison of the control track and tonewheel signals, the resistance in the second section of the phase shifter is effectively "modulated" by the error signal. If the error voltage tends to rise, implying that the capstan motor is running too slow, the gain of V1 will increase slightly, causing a decrease in the apparent resistance of the phaseshift network. This decreased resistance causes an increase in the frequency at which the phase shift totals 180 degrees, and thus slightly increases the frequency of the oscillator. Since the motor is driven synchronously, it also increases slightly in speed to restore the proper speed to the tape.

The third section of the phase-shift network is a simple capacitor and resistor. The output of the oscillator is attenuated by a 1.5-megohm resistor (R108) in series with a 100K resistor (R109) and applied to the grid of a cathode follower, V4B. In the output of this cathode follower, there are two phase-shift networks to provide two signals in phase quadrature, and a pair of potentiometers R112 and R113 for adjusting the amplitude of the two phases. (Note that the OFF-ON relay, K6, stops the capstan motor by grounding the signal at the grid of V4B.) The two phases are then coupled to the Capstan Power Amplifiers (units 401, 402) before driving the capstan motor.

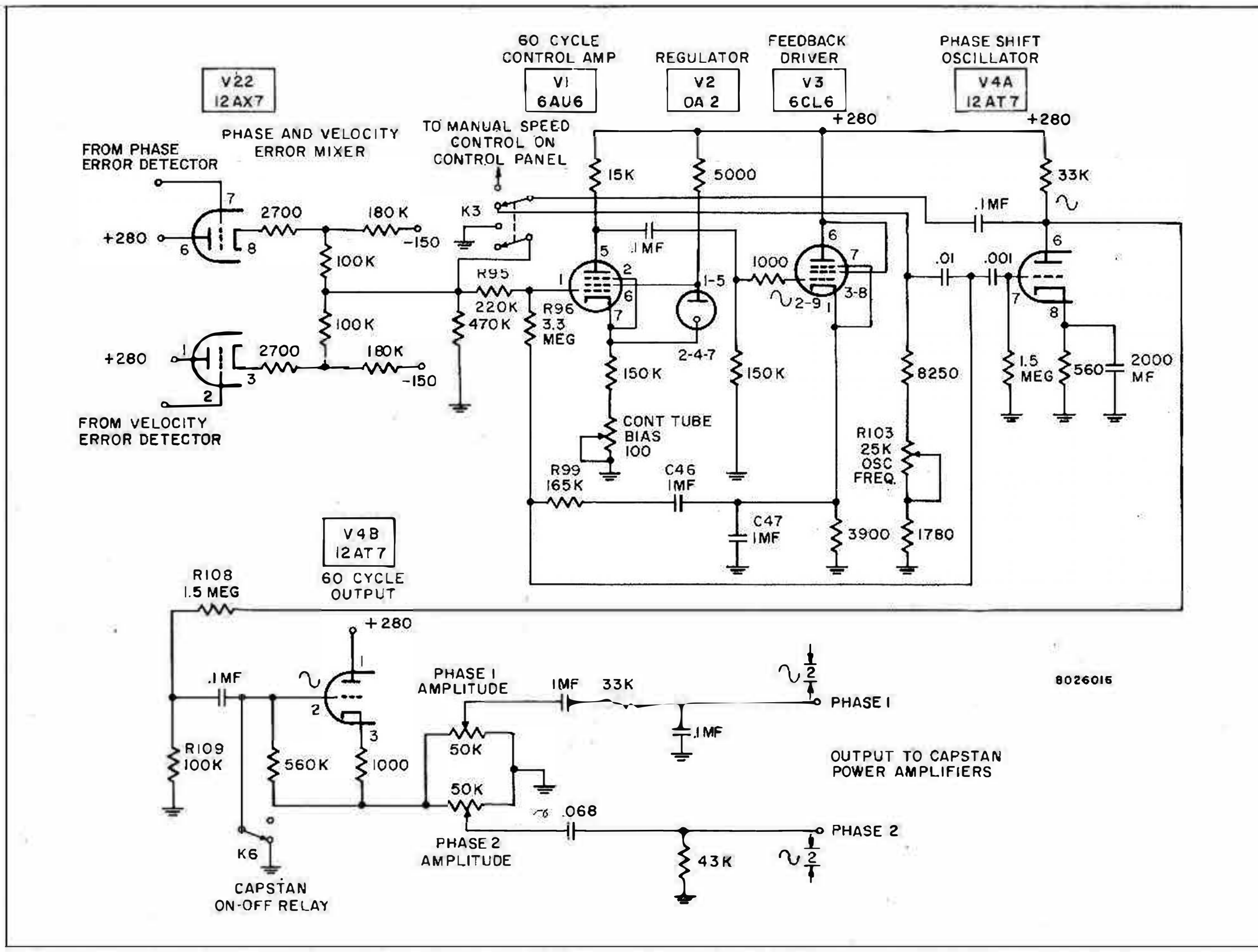


Figure CS-11. 60-Cycle Oscillator and Output Circuits

Control System

The capstan servo consists of five relays which control its functioning in the system (refer to schematic diagram figure CS-22). The purpose of each relay and its function is as follows:

Relay K1; switches the amplitude of the sawtooth by transferring the sawtooth at the bridge to either the playback or the record gain controls (R34, R127). Relay K1 is energized when the machine is in the RECORD and SETUP modes; de-energized in all other modes.

Relay K2; does the switching of the record/playback head and the simultaneous play head. Relay K2 has three sections. These sections transfer the record/playback head from the input transformer, T1, to the driver tube V11, and the simultaneous play head from OFF to the input transformer T1. Relay K2 is energized in the RECORD AND SETUP modes; and de-energized in all other modes.

Relay K3; this is the manual speed control relay. This relay is de-energized at all times except when the manual speed knob on the control panel is depressed, when at such time, it is desired to control the speed of the tape manually.

Relay K6; the capstan ON-OFF relay. This relay switches the capstan motor on and off by disconnecting the oscillator output which is responsible for driving the capstan motors.

TABLE FOR FIGURE CS-11

Symbol	*Pin Number*	*Reference to Figure Waveform*
V1	1 5 7	CS-15B CS-15C CS-15D
V3	1	CS-15E
V4	2 3 6 7	CS-15H CS-15I CS-15F CS-15G
TP1 and 2 TP5 and 6		CS-15J CS-15K

Relay K6, is energized in the PLAY, RECORD, SETUP, and WIND modes. In the STOP mode, K6 is de-energized; in this mode one section of K6 grounds the 60-cycle oscillator output to the power amplifiers to prevent the capstan motor from running in this mode. The other two sections ground the filter capacitors in the phase and velocity loops to prevent a false error signal from appearing at these points after a fast rewind and then a quick return to STOP and then to PLAY.

Relay K5; Record-Playback switching of the control signal amplifier. This relay has two sections. One section of K5 transfers the playback amplifier from the input transformer T1 to the 60-cycle oscillator. The second section grounds the 60-cycle signal during playback, and grounds the velocity loop during record.

Relay K5 is energized in the record and set-up modes; in PLAY, WIND, and STOP, it is de-energized.

MAINTENANCE

Setup Procedure

To set up the capstan servo chassis the following equipment is required.

1. Tektronix Type 535 oscilloscope or equivalent.
2. Vacuum tube voltmeter.
3. Reel of tape.

Before adjusting the capstan servo chassis make certain that the headwheel servo system and capstan power amplifiers are functioning normally. Then proceed as directed in the following table:

ADJUSTMENTS ON CAPSTAN SERVO CHASSIS

Step No.	*See Fig. No.*	*Mode*	*Connect Scope To**	*Procedure*
1		SU	Press OSCILLOSCOPE H.W. SERVO button or MONITOR T.W. PULSE button on CRO/Monitor Switcher.	Observe CRO waveform monitor or picture monitor to make certain that headwheel servo is locked.
2	12A	SU	"A" input to FRAME PULSE (TP-8).	Check for normal waveform.
3	12B	SU	"B" input to 240 T.W. IN (TP-7).	Check for normal waveform.
4	12C	SU	"B" input to D. 240 T.W. IN (TP-13).	Check for normal waveform.
5		STOP		Press STOP button and thread a tape on recorder.
6		STOP		Turn OSC. FREQ. control, R103, to mid position.
7		WIND		Press WIND button and adjust FORWARD-REVERSE knob (variac) until tape is stationary.
8	12D	WIND	PH-1 (TP-5).	Connect VTVM on dc range to CONTROL TUBE BIAS (TP-3). Adjust CONTROL TUBE BIAS control, R98, until 60 cycle sine wave on scope is as nearly stationary as possible. Check VTVM for reading of 4.2 $\pm$0.5 v dc at TP-3.
9		SU		Press SETUP button on control panel.
10	12E	SU	SAWTOOTH (TP-4).	Turn RECORD LOOP GAIN control, R127, fully clockwise and observe waveform. Pip should be locked near center of every fourth sawtooth.
11	12F	SU	Same as preceding step.	Adjust sweep rate of scope until period of sawtooth occupies 10 horizontal divisions on scope graticule. Then expand sweep 10 times and observe the amount of jitter (total horizontal travel) of the pips. Jitter should not exceed 1 division (1% of sawtooth period).
12	12G	SU	MON. C.T. REC. (TP-11).	Check position of frame pulse. Adjust DELAY 240 SQ. WAVE control, R44, on tone wheel amplifier (if necessary) until frame pulse is centered at the top of the 240 cycle sine wave.

ADJUSTMENTS ON CAPSTAN SERVO CHASSIS (continued)

Step No.	*See Fig. No.*	*Mode*	*Connect Scope To**	*Procedure*
13	12H, I, J	REC	MON. C.T. P.B (TP-10), or press OSCILLOSCOPE C.T. P.B. button on CRO/Monitor Switcher.	Record 5 minutes of picture. While recording observe simultaneous control-track playback signal on oscilloscope or waveform monitor. Waveform should appear as in figure 12H. If necessary adjust 240 REC. AMP. control, R54, until desired waveform is obtained. (Figs. 12I and 12J show waveform obtained when control track current is too low or too high.)
14	12G	REC	MON. C.T. REC. (TP-11).	Adjust FRAME PULSE AMP. control, R50, until amplitude of frame pulse is $1\frac{1}{2}$ times that of sine wave.
15		WIND, PLAY		Rewind and then play back segment of tape recorded in step 13. Make all the following adjustments while playing back the tape.
16	12K	PLAY	"A" input to SAWTOOTH (TP-4). "B" input to TRAPEZOID (TP-16).	Hold down the momentary pushbutton marked SETUP on the capstan servo chassis. Adjust OSC. FREQ. control, R103, (if necessary) to lock pip on sawtooth. Adjust P.B. LOOP GAIN control, R34, until sawtooth amplitude is 20 v p-p. Release button.
17	12L	PLAY	Same as preceding step.	Adjust DELAY control, R177, until pip is in center of negative slope on trapezoid (fig. 12L). Adjust VEL. GAIN control, R171, until trapezoid amplitude is 15 v p-p.
18	12K, L	PLAY	Same as preceding step.	Press pushbutton marked SETUP on capstan servo chassis and note position of pip on sawtooth (fig. 12K). Release button and adjust DELAY control, R177, until pip is in same position on slope as when button was pressed. The pip on the trapezoid (fig. 12L) should still be near center of slope.
19	12F	PLAY	Same as preceding step.	Adjust sweep rate of scope until period of sawtooth occupies 10 horizontal divisions on scope graticule. Then expand sweep ten times, increase scope vertical gain to permit observation of pip, and observe drift and jitter of pip. If jitter (total horizontal excursion) is greater than three divisions (3% of sawtooth period) reduce VELOCITY GAIN, LOOP GAIN, or both. If a long slow drift occurs, increase LOOP GAIN.
20	12K	PLAY	Same as preceding step.	If the gain of the velocity loop is too low, the lock-in range of the OSC. FREQ. control, R103, will be too narrow. To check the lock-in range, proceed as follows: a. Turn OSC. FREQ. control fully counterclockwise. If pip is not locked on slope of sawtooth (fig. 12K) slowly turn control clockwise until pip locks. Then note setting of control. b. Turn OSC. FREQ. control fully clockwise. If pip is not locked on slope, slowly turn control counterclockwise until pip locks. Then note new control setting. c. The difference between the two control settings in *a* and *b* (lock-in range) should be 180 degrees (58 to 62 cps). If range is narrow increase VELOCITY GAIN and then repeat the jitter and lock-in range tests (steps 19 and 20).

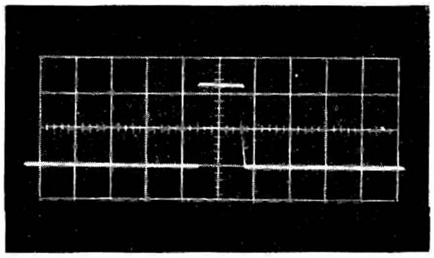
* Trigger scope sweep with reference pulse from REF test point on reference generator chassis (unit 407).

Troubleshooting

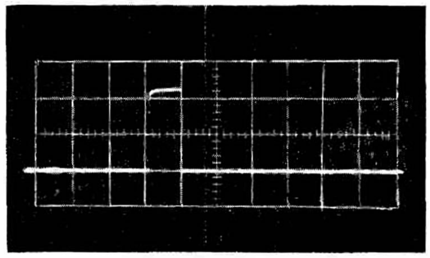
The schematic diagram, figure CS-22, should be referred to when troubleshooting. Also figures CS-13 through CS-20, can be used for comparing waveforms when checking the unit for proper operation.

With each simplified circuit diagram, a table is also available for referring various points in the circuit to waveforms that are shown in this section. Figure CS-21, shows component identification which may be useful during troubleshooting.

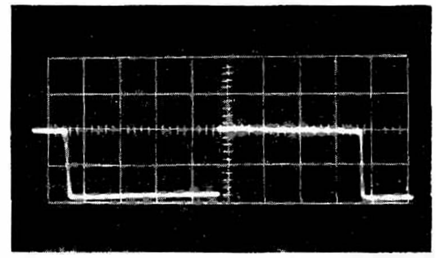
NOTES



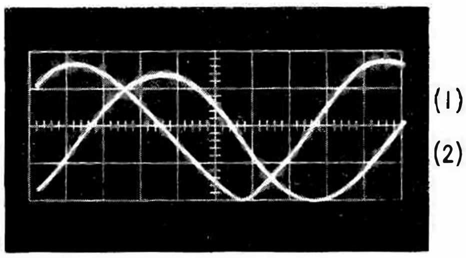
A. FRAME PULSE (TP-8)
50 μsec/div., 2 v/div.



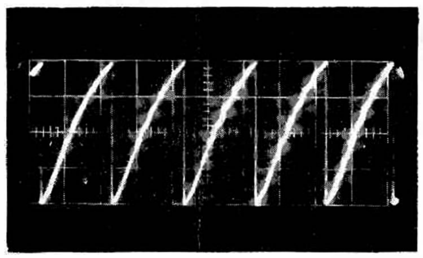
B. 240 TW IN (TP-7)
50 μsec/div., 2 v/div.



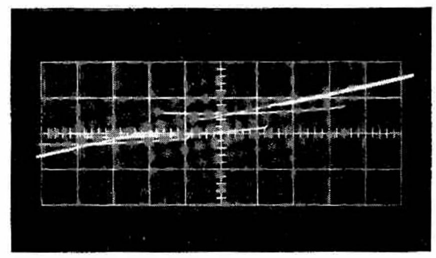
C. D. 240 IN (TP-13)
50 μsec/div., 2 v/div.



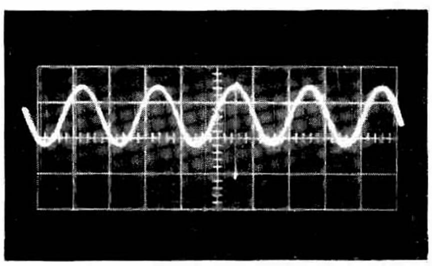
D. (1) PH-1 (TP-5)
(2) PH-2 (TP-6)
2000 μsec/div., 100 v/div.



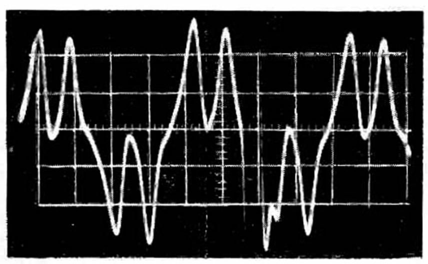
E. SAWTOOTH (TP-4).
2000 μsec/div., 10 v/div.
SETUP (or RECORD)



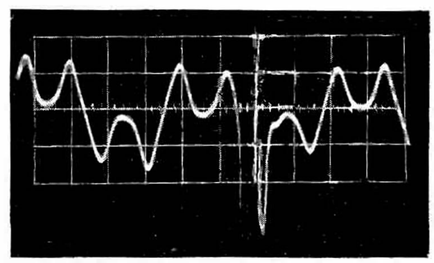
F. SAWTOOTH (TP-4), Double Exposure Showing Jitter
(See Table, step 11 or 17)



G. MON C.T. REC. (TP-11)
2000 μsec/div., 0.5 v/div.

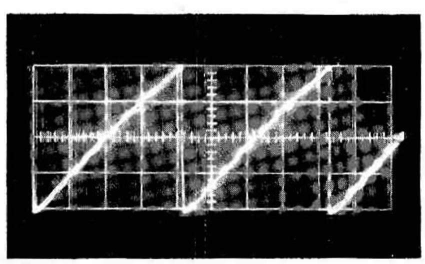


H. MON. C.T. P.B. (TP-10)
Normal Record Current
1000 μsec/div., 0.1 v/div.

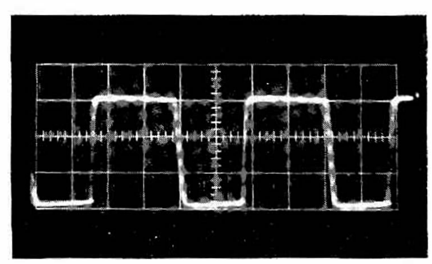


I. MON. C.T. P.B. (TP-10)
Low Record Current
1000 μsec/div., 0.1 v/div.

J. MON. C.T. P.B. (TP-10)
High Record Current
1000 μsec/div., 0.1 v/div.



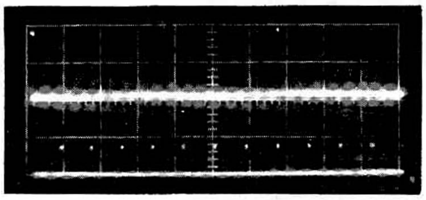
K. SAWTOOTH (TP-4)
1000 μsec/div. 5 v/div.
PLAY mode



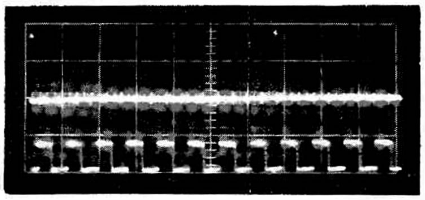
L. TRAPEZOID (TP-16)
1000 μsec/div., 5 v/div.

Figure CS-12. Test Point Waveforms

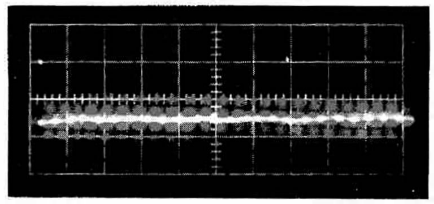
NOTE: All waveforms from Figure CS-13A through Figure CS-15A, apply to the RECORD mode. Waveforms are the same for SETUP except where indicated.



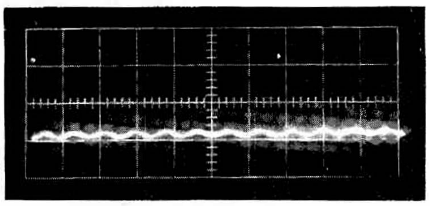
A. Top: Frame TP8, 5000 usec/2m, 2v/cm
Bottom: TW TP7, 5000 usec/cm, 5v/cm



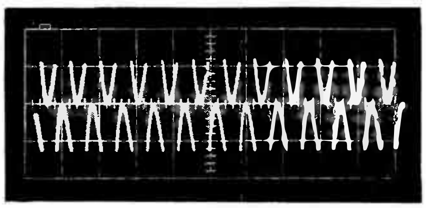
B. Frame TP8, 5000 usec/cm, 2v/cm
Delayed TW TP13, 5000 usec/cm, 5v/cm



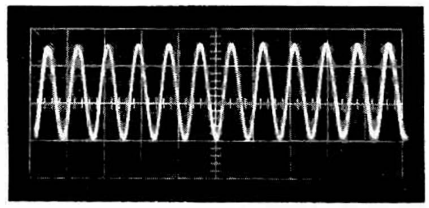
C. V11 pin 1
5000 usec/cm, .05v/cm



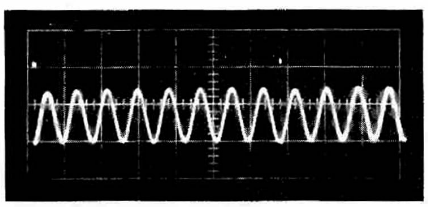
D. V11 pin 3
5000 usec/cm, 2v/cm



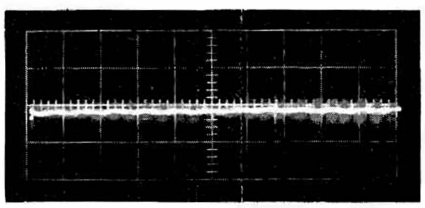
E. FILTER IN
5000 usec/cm, 1v/cm



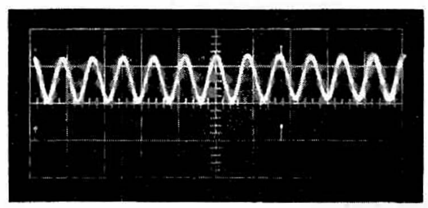
F. FILTER OUT
5000 usec/cm, 1v/cm



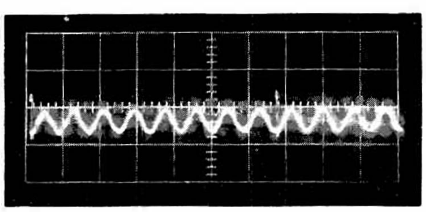
G. V11 pin 7
5000 usec/cm, 1v/cm



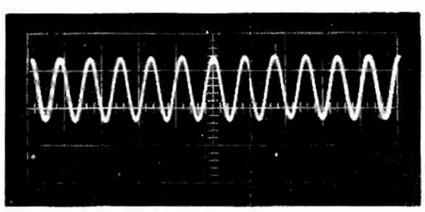
H. V11 pin 9
5000 usec/cm, 10v/cm



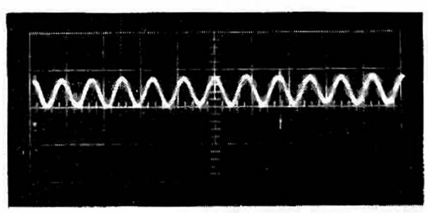
I. V17 pin 7
5000 usec/cm, .05v/cm



J. V17 pin 6
5000 usec/cm, .5v/cm

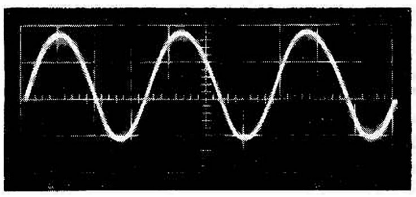


K. V17 pin 1
5000 usec/cm, 1v/cm

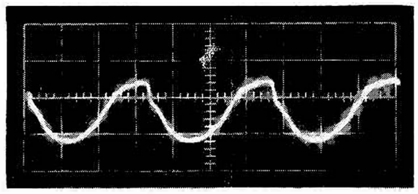


L. V17 pin 8
5000 usec/cm, .05v/cm

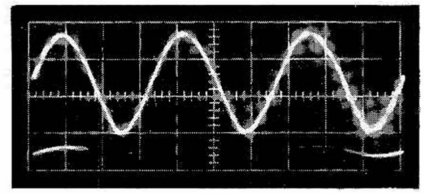
Figure CS-13. Waveforms and Voltages



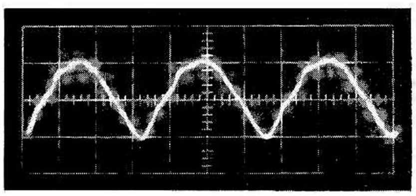
A. V16 pin 2
5000 usec/cm, .05v/cm



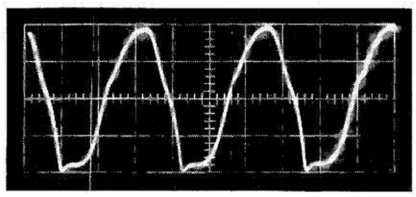
B. V16 pin 1
5000 usec/cm, .5v/cm



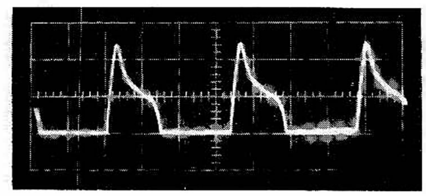
C. V16 pin 3
5000 usec/cm, .05v/cm



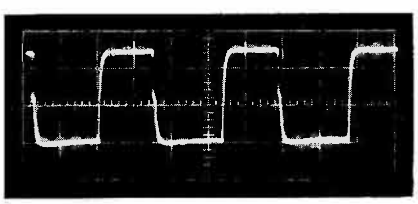
D. V16 pin 6
5000 usec/cm, 5v/cm



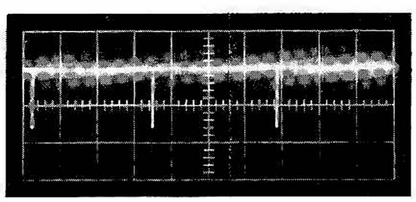
E. V12 pin 6
5000 usec/cm, 50v/cm



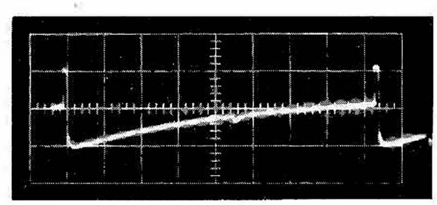
F. V13 pin 3
5000 usec/cm, 20v/cm



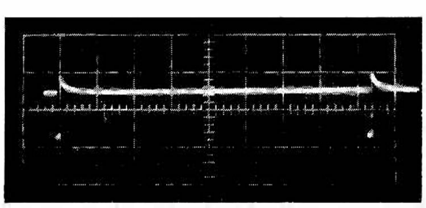
G. V13 pin 6
5000 usec/cm, 20v/cm



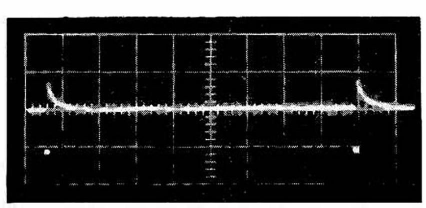
H. V12 pin 2
5000 usec/cm, 10v/cm



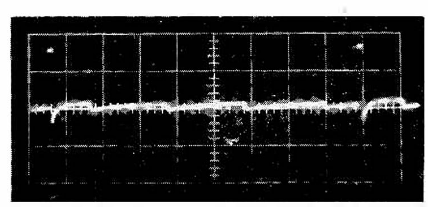
I. V12 pin 1
2000 usec/cm, 50v/cm



J. V7 pin 1; TP15
2000 usec/cm, 20v/cm



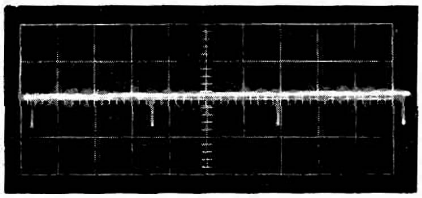
K. V5 pin 5
2000 usec/cm, 50v/cm



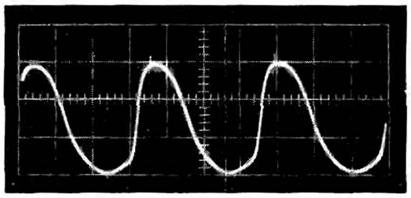
L. V5 pin 7
2000 usec/cm, 10v/cm

Figure CS-14. Waveforms and Voltages

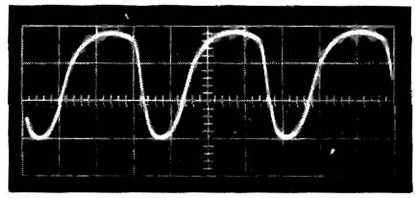
NOTE: CS-15B through CS-15K apply to REC., P.B. and SETUP.



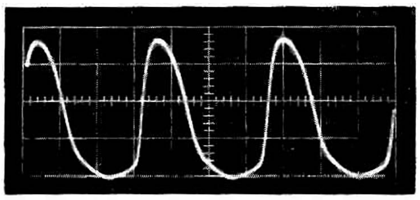
A. V5 pin 1
5000 usec/cm, .5v/cm



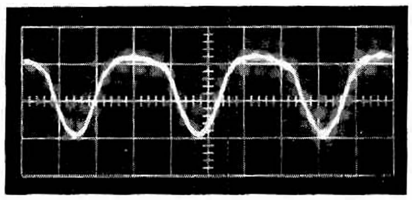
B. V1 pin 1
5000 usec/cm, .5v/cm



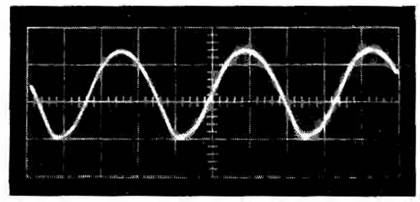
C. V1 pin 5
5000 usec/cm, 5v/cm



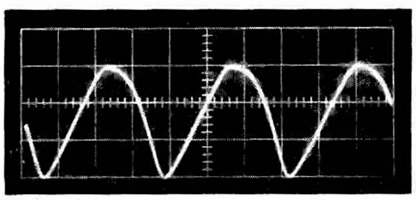
D. V1 pin 7
5000 usec/cm, .05v/cm



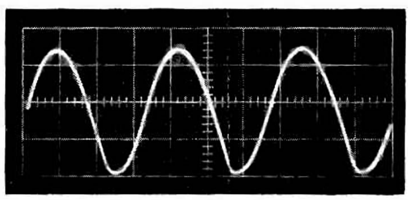
E. V3 pin 1
5000 usec/cm, 5v/cm



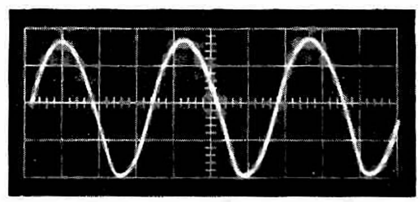
F. V4 pin 6
5000 usec/cm, 50v/cm



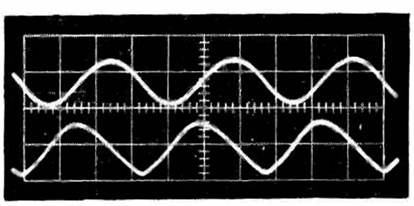
G. V4 pin 7
5000 usec/cm, 2v/cm



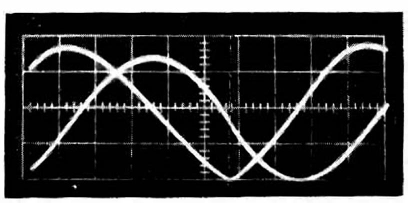
H. V4 pin 2
5000 usec/cm, 2v/cm



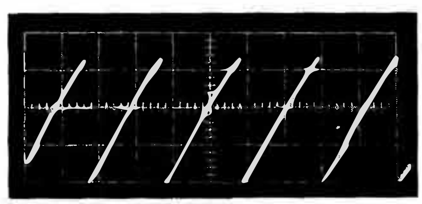
I. V4 pin 3
5000 usec/cm, 2v/cm



J. Top: PH-1 (TP1)
Lower: PH-2 (TP2)
5000 usec/cm, 2v/cm

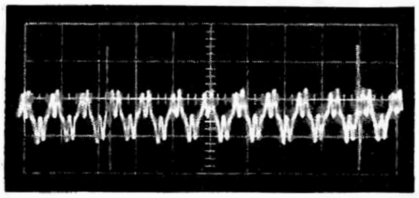


K. Top: PH-1 (TP5)
Lower: PH-2 (TP6)
2000 usec/cm, 100v/cm

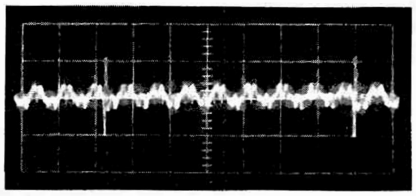


L. TP4; REC., SETUP
2000 usec/cm, 10v/cm

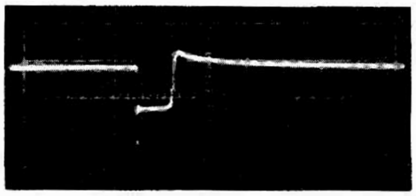
Figure CS-15. Waveforms and Voltages



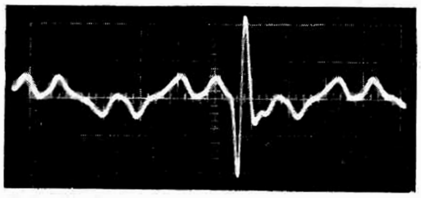
A. V15 pin 2 (TP12); RECORD only; 5000 usec/cm, .05v/cm



B. V15 pin 1; RECORD only; 5000 usec/cm, 1v/cm



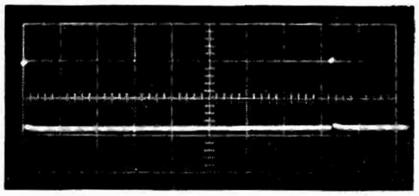
C. TP15; REC., SETUP; 200 usec/cm, 20v/cm



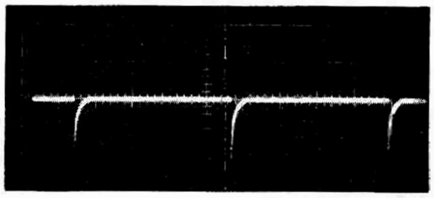
D. TP10; RECORD only; Correct Record Current; 1000 usec/cm, .5v/cm

E. TP10; RECORD only; Low Record Current; 1000 usec/cm, .5v/cm

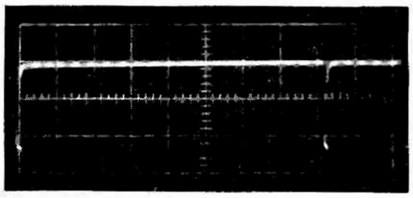
F. TP10; RECORD only; High Record Current; 1000 usec/cm, 0.1v/cm



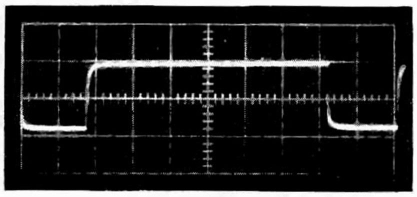
G. TP7, 240 TW; REC., P.B., SETUP; 500 usec/cm, 2v/cm



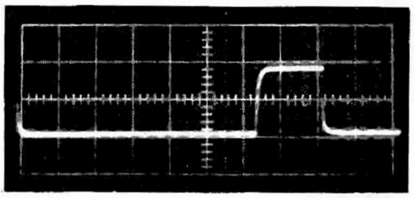
H. CR5, CR6; REC., P.B., SETUP, 1000 usec/cm, 50v/cm



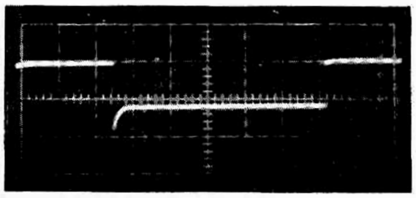
I. V9 pin 1; REC., P.B., SETUP; 500 usec/cm, 20v/cm



J. V10 pin 6; REC., P.B., SETUP; CAP PHASE Control max. ccw; 500 usec/cm, 100v/cm



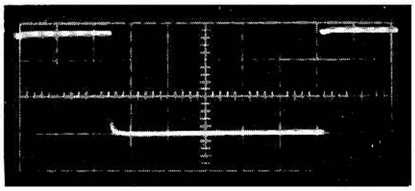
K. V10 pin 6; REC., P.B., SETUP; CAP PHASE Control max. cw; 500 usec/cm, 100v/cm



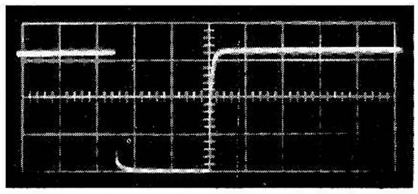
L. V10 pin 1; REC., P.B., SETUP; CAP PHASE Control at 5; 500 usec/cm, 50v/cm

Figure CS-16. Waveforms and Voltages

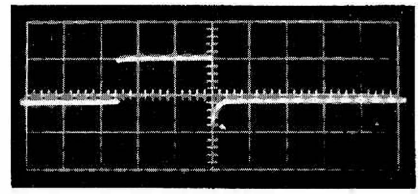
NOTE: CS-17A through CS-17L apply to SETUP, REC., and PLAYBACK.



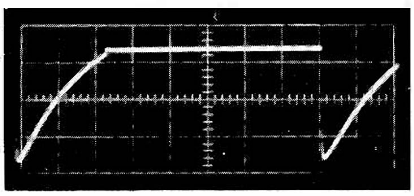
A. V10 pin 8; CAP PHASE Control at 5; 500 usec/cm, 10v/cm



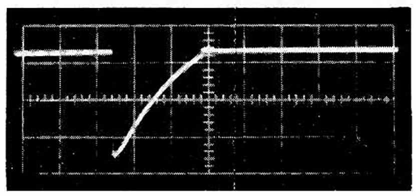
B. V14 pin 6; CAP PHASE Control at 5; 500 usec/cm, 50v/cm



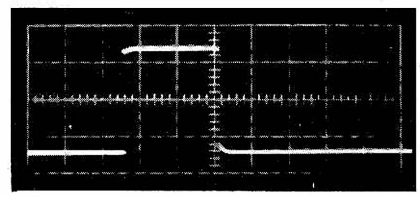
C. V14 pin 1; CAP PHASE Control at 5; 500 usec/cm, 50v/cm



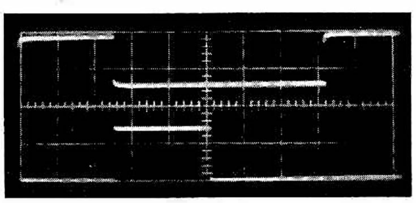
D. V10 pin 2; CAP PHASE Control at 5; 500 usec/cm, 50v/cm



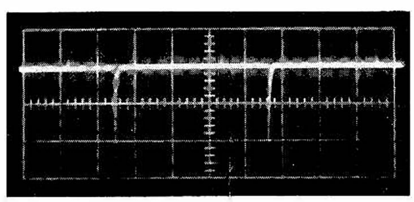
E. V14 pin 2; CAP PHASE Control at 5; 500 usec/cm, 50v/cm



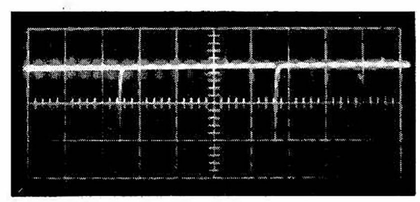
F. V14 pin 8 500 usec/cm, 10v/cm



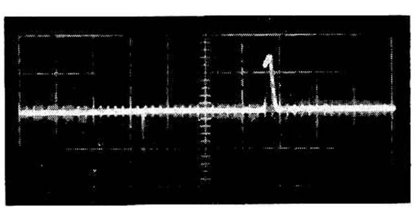
G. R76 Top; R85 Bottom 500 usec/cm, 20v/cm



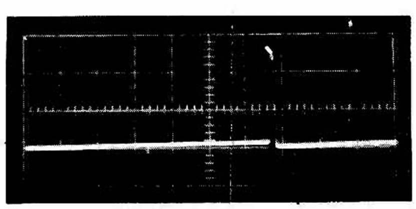
H. V9 pin 7 1000 usec/cm, 10v/cm



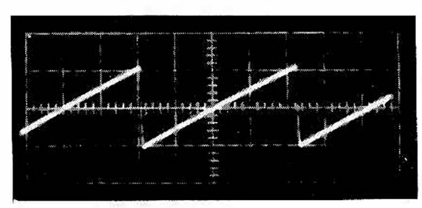
I. V9 pin 7 1000 usec/cm, 10v/cm



J. V9 pin 6 500 usec/cm, 20v/cm

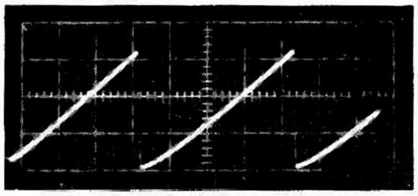


K. V8 pin 7 500 usec/cm, 5v/cm

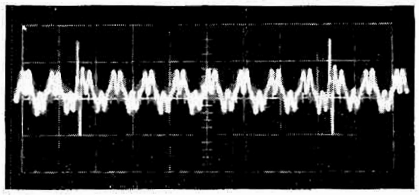


L. V8 pin 6 1000 usec/cm, 20v/cm

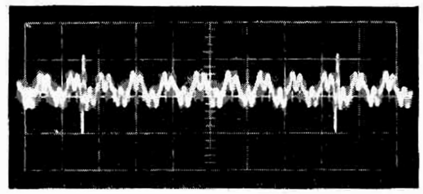
Figure CS-17. Waveforms and Voltages



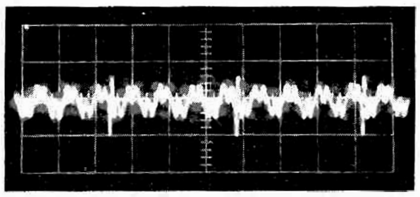
A. V8 pin 3; REC., P.B., SETUP;
1000 usec/cm, 10v/cm



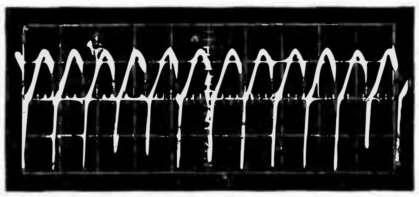
B. TP12, V15 pin 2, V16 pin 2;
P.B.; 5000 usec/cm, .05v/cm
(B only Calib)



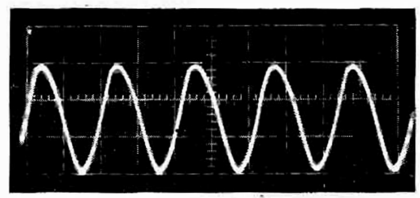
C. V15 pin 1; P.B.;
5000 usec/cm, .5v/cm



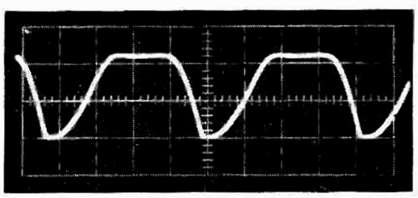
D. TP10; P.B.;
5000 usec/cm, .5v/cm



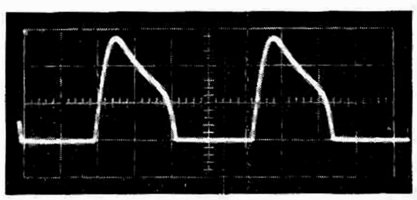
E. V16 pin 1; P.B.;
5000 usec/cm, .5v/cm



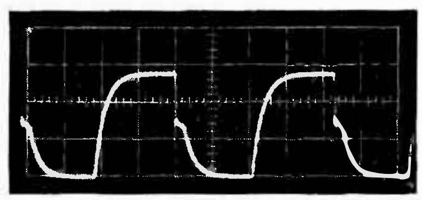
F. V16 pin 6; P.B.;
2000 usec/cm, 5v/cm



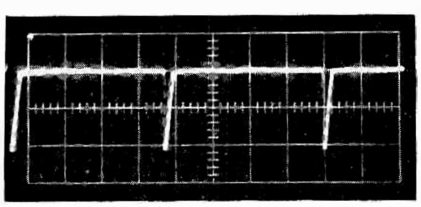
G. V12 pin 6; P.B.;
1000 usec/cm, 100v/cm



H. V13 pin 3, P.B.;
1000 usec/cm, 20v/cm

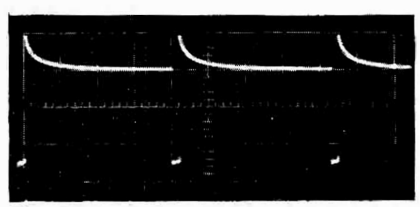


I. V13 pin 6; P.B.;
1000 usec/cm, 20v/cm



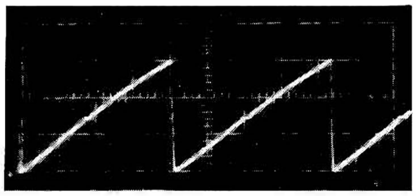
J. V12 pin 2; P.B.;
1000 usec/cm, 10v/cm

K. V12 pin 1; P.B.;
1000 usec/cm, 50v/cm

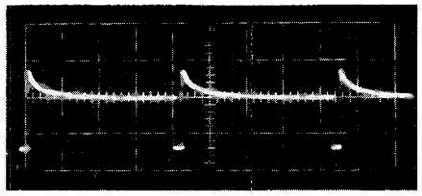


L. TP15, V7 pin 1; P.B.;
1000 usec/cm, 20v/cm

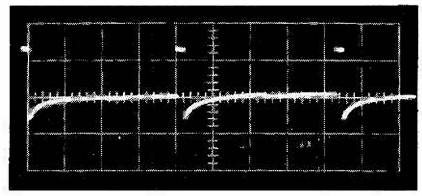
Figure CS-18. Waveforms and Voltages



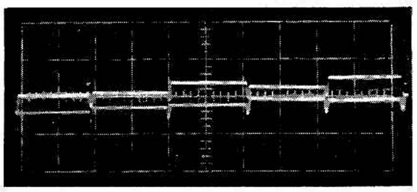
A. TP4; P.B.;
1000 usec/cm, 10v/cm



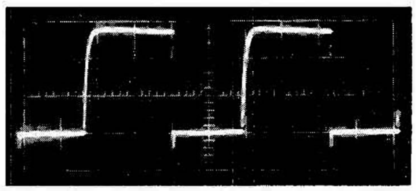
B. V5 pin 5; P.B.;
1000 usec/cm, 10v/cm



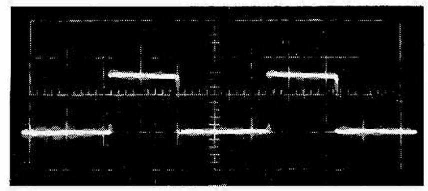
C. V5 pin 7; P.B.;
1000 usec/cm, 20v/cm



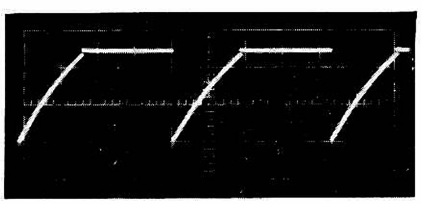
D. V5 pin 1; P.B.;
2000 usec/cm, .5v/cm



E. TP14; P.B.;
1000 usec/cm, 50v/cm

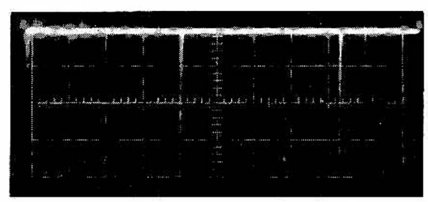


F. V18 pin 3; P.B.;
1000 usec/cm, 1v/cm

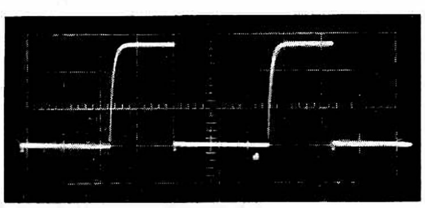


G. V18 pin 7; P.B.;
1000 usec/cm, 50v/cm

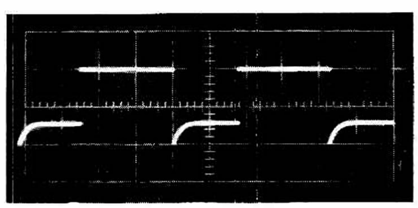
H. V18 pin 6; P.B.;
1000 usec/cm, 50v/cm



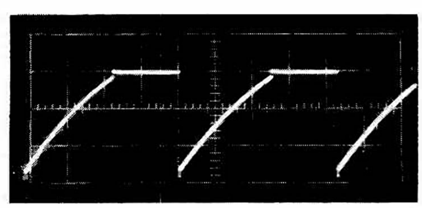
I. CR12, CR13; P.B.;
1000 usec/cm, 20v/cm



J. V19 pin 6; P.B.;
1000 usec/cm, 50v/cm

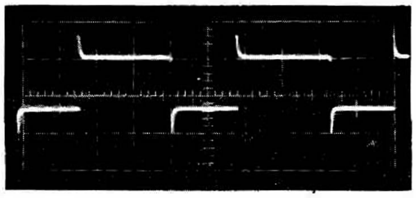


K. V19 pin 1; P.B.;
1000 usec/cm, 50v/cm

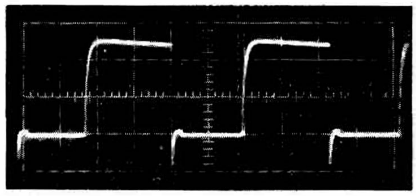


L. V19 pin 2; P.B.
1000 usec/cm, 50v/cm

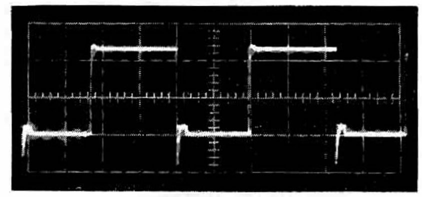
Figure CS-19. Waveforms and Voltages



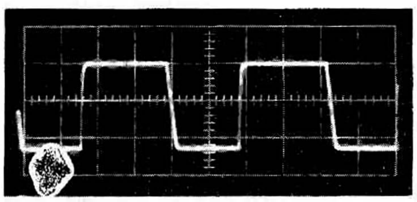
**A. V19 pin 8; P.B.;
1000 usec/cm, 10v/cm**



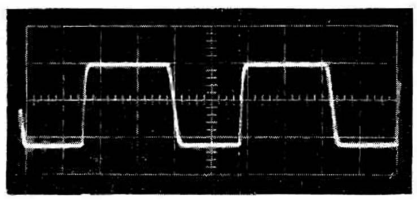
**B. V21 pin 3; P.B.;
1000 usec/cm, 20v/cm**



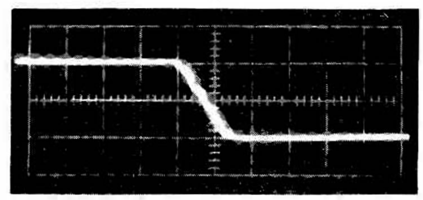
**C. V24 pin 2; P.B.;
1000 usec/cm, 10v/cm**



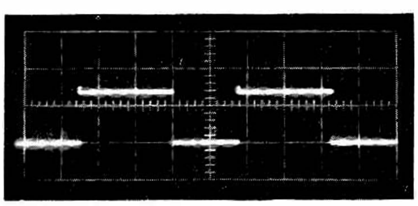
**D. V24 pin 5; P.B.;
1000 usec/cm, 10v/cm**



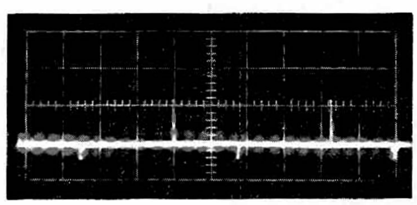
**E. V21 pin 7; P.B.;
1000 usec/cm, 5v/cm**



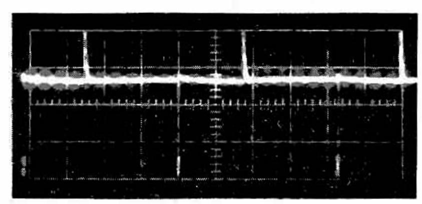
**F. TP16; P.B.;
200 usec/cm, 5v/cm**



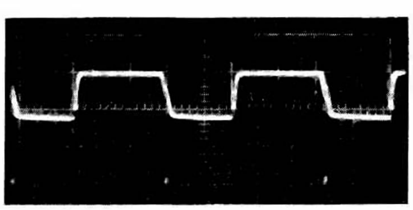
**G. V20 pin 2; P.B.;
1000 usec/cm, 10v/cm**



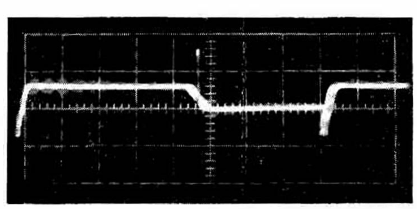
**H. V20 pin 1; P.B.;
1000 usec/cm, 50v/cm**



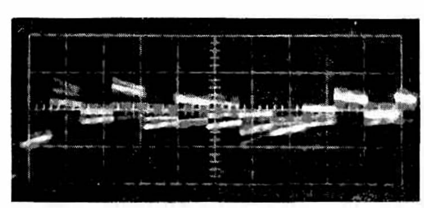
**I. V20 pin 6; P.B.;
1000 usec/cm, 100v/cm**



**J. V23 pin 5; P.B.;
1000 usec/cm, 10v/cm**



**K. V23 pin 7; P.B.;
1000 usec/cm, 20v/cm**



**L. V23 pin 1; P.B.;
5000 usec/cm, 1v/cm**

Figure CS-20. Waveforms and Voltages

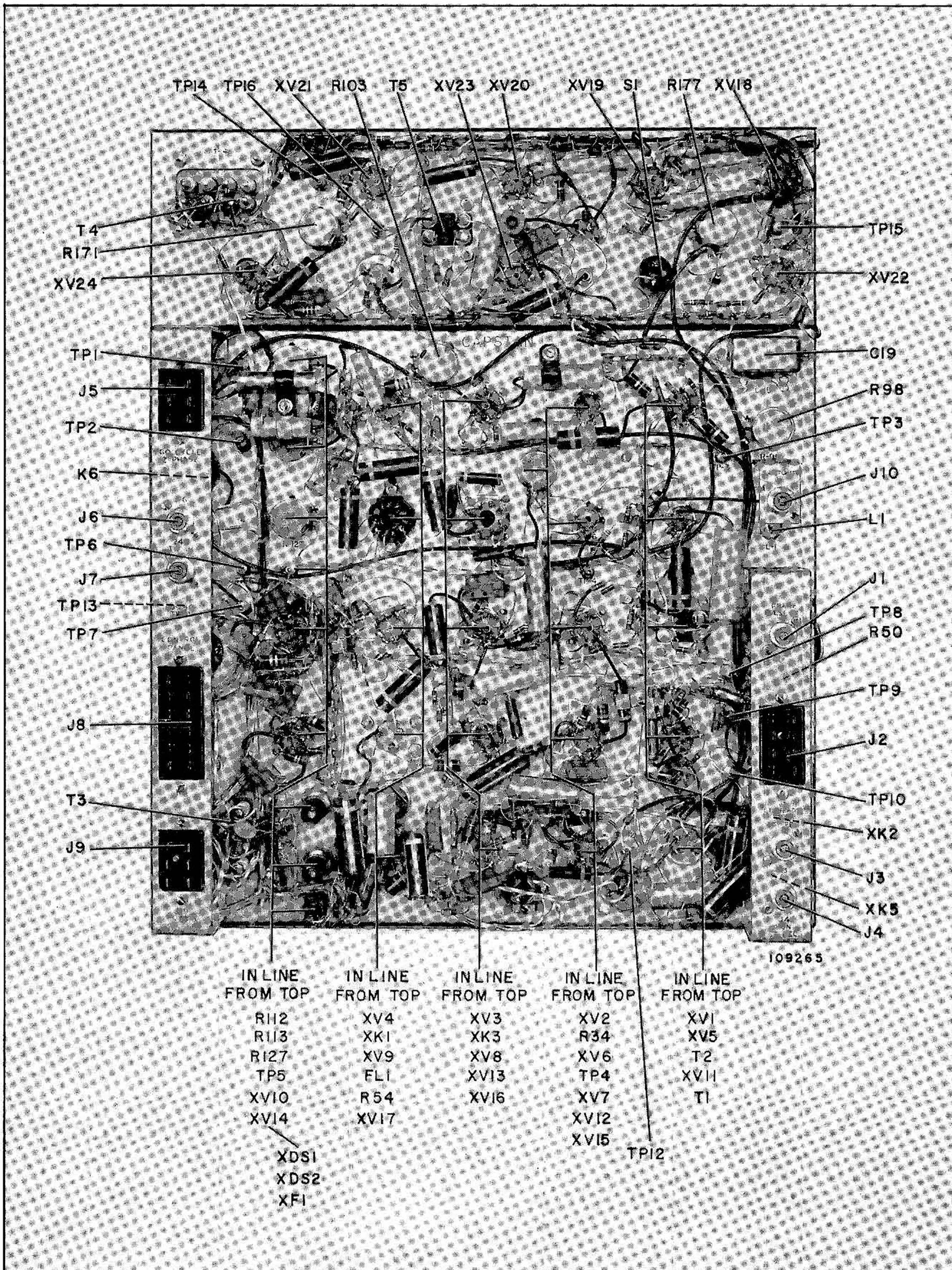


Figure CS-21. Rear View of Capstan Servo Chassis, Component Identification

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
CAPSTAN SERVO (8973706-502)			18
			CAPACITORS:
C1A/D	213188	458558-49	electrolytic, 30/30/40/40 μf 450 v
C2,C3		735715-163	paper, 0.01 μf ±10%, 400 v
C4	206732	458557-3	electrolytic, 100 μf 150 v
C5,C6		735715-163	paper, 0.01 μf ±10%, 400 v
C7		735715-179	paper, 0.22 μf ±10%, 400 v
C8,C9		727876-259	mica, 3300 μμf ±5%, 500 v char "B"
C10		727876-266	mica, 6200 μμf ±5%, 500 v char "B"
C11,C12		735715-163	paper, 0.01 μf ±10%, 400 v
C13		727876-249	mica, 1200 μμf ±5%, 1000 v char "B"
C14,C15		735715-163	paper, 0.01 μf ±10%, 400 v
C16A/D	213188	458558-49	electrolytic, 30/30/40/40 μf 450 v
C17	211560	737818-97	paper, 1 μf ±10%, 400 v
C18		735715-175	paper, 0.1 μf ±10%, 400 v
C19	218626	8976977-1	paper, 5 μf 150 v
C20		735715-171	paper, 0.047 μf ±10%, 400 v
C21			Not Used
C22		735715-175	paper, 0.1 μf ±10%, 400 v
C23,C24		735715-179	paper, 0.22 μf ±10%, 400 v
C25			Not Used
C26	218624	458557-23	electrolytic, 60 μf 350 v
C27		735715-163	paper, 0.01 μf ±10%, 400 v
C28	94667	442901-48	electrolytic, 50 μf 25 v
C29,C30		735715-175	paper, 0.1 μf ±10%, 400 v
C31		735715-163	paper, 0.01 μf ±10%, 400 v
C32		735715-175	paper, 0.1 μf ±10%, 400 v
C33			Not Used
C34		727876-67	mica, 6800 μμf ±20%, 500 v char "B"
C35			Not Used
C36,C37		735715-175	paper, 0.1 μf ±10%, 400 v
C38		727876-31	mica, 220 μμf ±20%, 1000 v char "B"
C39		727876-245	mica, 820 μμf ±5%, 1000 v char "B"
C40 to C42		727876-31	mica, 220 μμf ±20%, 1000 v char "B"
C43		727876-245	mica, 820 μμf ±5%, 1000 v char "B"
C44		727876-31	mica, 220 μμf ±20%, 1000 v char "B"
C45		735715-175	paper, 0.1 μf ±10%, 400 v
C46,C47	211741	737818-17	paper, 1 μf ±10%, 100 v
C48	217265	737816-93	paper, 0.1 μf ±10%, 400 v
C49	219588	993025-485	mica, 10,000 μμf ±5%, 100 v
C50	219195	993025-461	mica, 1000 μμf ±5%, 100 v
C51	96185	458557-2	electrolytic, 2000 μf, 6 v
C52		735715-175	paper, 0.1 μf ±10%, 400 v
C53	97562	737816-17	paper, 1 μf ±10%, 100 v
C54		735715-175	paper, 0.1 μf ±10%, 400 v
C55		735715-173	paper, 0.068 μf ±10%, 400 v
C56 to C58		735715-163	paper, 0.01 μf ±10%, 400 v
C59,C60		735715-175	paper, 0.1 μf ±10%, 400 v
C61		735715-179	paper, 0.22 μf ±10%, 400 v
C62	218625	458558-50	electrolytic, 100 μf 450 v
C63		735715-179	paper, 0.22 μf ±10%, 400 v
C64	206013	458557-7	electrolytic, 20 μf 450 v
C65 to C67		8811182-5	ceramic, 10,000 μμf −20 +100%, 450 v
C68	212980	471574-27	electrolytic, 10 μf 350 v
C69			Not Used
C70,C71	217350	8959154-108	electrolytic, 10 μf 25 v
C72		8811182-5	ceramic, 10,000 μμf −20 +100%, 450 v
C73		727851-135	mica, 330 μμf ±10%, 500 v char "B"
C74A/B	32342	95695-37	electrolytic, 10/10 μf 450 v
C75		735715-175	paper, 0.1 μf ±10%, 400 v
C76		8811182-5	ceramic, 10,000 μμf −20 +100%, 450 v
C77		735715-171	paper, 0.047 μf ±10%, 400 v
C78	219661	8924416-119	mica, 2700 μμf ±1%, 500 v
C79		727851-123	mica, 100 μμf ±10%, 500 v char "B"

Symbol No.	Stock No.	Drawing No.	Description
C80		727876-163	mica, 4700 $\mu\mu$f ±10%, 500 v char "B"
C81	219661	8924416-119	mica, 2700 $\mu\mu$f ±1%, 500 v
C82		735715-175	paper, 0.1 μf ±10%, 400 v
C83, C84	209079	737816-95	paper, 0.22 μf ±10%, 400 v
C85A/B	32342	95695-37	electrolytic, 10/10 μf 450 v
C86		727876-167	mica, 6800 $\mu\mu$f ±10%, 500 v char "B"
C87		735715-175	paper, 0.1 μf ±10%, 400 v
C88	211169	737863-37	paper, 1 μf ±10%, 100 v
C89 to C91		8811182-5	ceramic, 10,000 $\mu\mu$f -20 +100%, 450 v
C92, C93			Not Used
C94	211545	471574-32	electrolytic, 5 μf 450 v
C95	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C96	211741	737818-17	paper, 1 μf ±10%, 100 v
CR1 to CR9	99483		Diode: type 1N54A
CR10 to CR15	108915		Diode: type 1N2069
DS1, DS2	101857	872291-9	Lamp: indicator
F1	218628	990157-107	Fuse: 3/4 A 250 v
FL1	218623	8976975-1	Filter: electrical, 240 cycle
J1	51800	255223-2	Connector: coax, chassis mtg.
J2	56077	727969-5	Connector: female, 8 contacts
J3, J4	51800	255223-2	Connector: coax, chassis mtg.
J5	51594	727969-1	Connector: female, 6 contact
J6, J7	51800	255223-2	Connector: coax, chassis mtg.
J8	53140	727969-15	Connector: female, 12 contacts
J9	51604	727969-3	Connector: male, 6 contact
J10, J11	51800	255223-2	Connector: coax, chassis mtg.
K1, K2	218223	460355-6	Relay: 3 P.D.T.
K3	206744	460355-2	Relay: D.P.D.T.
K4			Not Used
K5	218223	460355-6	Relay: 3 P.D.T.
L1	218622	8973724-1	Coil: 1.25 H 26 MA
L2			Not Used
L3	211803	8980021-1	Coil: 15/60 millihenry
P1			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P2	58978	727969-6	Connector: male, 8 contact
P3, P4	215661	252868-1	Connector: coax, cable mtg.
P5	51595	727969-2	Connector: male, 6 contacts
P6	215661	252868-1	Connector: coax, cable mtg.
P7			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P8	54253	727969-16	Connector: male, 12 contacts
P9	51607	727969-4	Connector: female, 6 contacts
P10	215661	252868-1	Connector: coax, cable mtg.
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-111	10 ohms, ±5%, ½ w
R2		82283-78	22,000 ohms ±10%, ½ w
R3		82283-65	1800 ohms, ±10%, ½ w
R4		82283-86	100,000 ohms, ±10%, ½ w
R5		82283-98	1 meg ±10%, ½ w
R6		82283-65	1800 ohms, ±10%, ½ w
R7		82283-74	10,000 ohms, ±10%, ½ w
R8		82283-98	1 meg ±10%, ½ w
R9		82283-90	220,000 ohms, ±10%, ½ w
R10		82283-71	5600 ohms, ±10%, ½ w
R11		82283-98	1 meg ±10%, ½ w
R12		82283-90	220,000 ohms, ±10%, ½ w
R13		82283-65	1800 ohms, ±10%, ½ w
R14, R15		82283-215	220,000 ohms, ±5%, ½ w
R16		82283-208	110,000 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R17		90496-82	47,000 ohms, ±10%, 1 w
R18		82283-56	330 ohms, ±10%, ½ w
R19, R20		82283-90	220,000 ohms, ±10%, ½ w
R21		82283-98	1 meg ±10%, ½ w
R22		99126-79	27,000 ohms, ±10%, 2 w
R23		82283-90	220,000 ohms, ±10%, ½ w
R24		82283-81	39,000 ohms, ±10%, ½ w
R25		82283-70	4700 ohms, ±10%, ½ w
R26		82283-98	1 meg ±10%, ½ w
R27		82283-102	2.2 meg ±10%, ½ w
R28		99126-78	22,000 ohms, ±10%, 2 w
R29		82283-98	1 meg ±10%, ½ w
R30		82283-54	220 ohms, ±10%, ½ w
R31		82283-78	22,000 ohms, ±10%, ½ w
R32		82283-54	220 ohms, ±10%, ½ w
R33		82283-87	120,000 ohms, ±10%, ½ w
R34	93175	8971860-110	variable, comp., 10,000 ohms, ±10%, 2 w
R35			Not Used
R36		82283-70	4700 ohms, ±10%, ½ w
R37		82283-98	1 meg ±10%, ½ w
R38			Not Used
R39		82283-191	22,000 ohms, ±5%, ½ w
R40		82283-82	47,000 ohms, ±10%, ½ w
R41		82283-90	220,000 ohms, ±10%, ½ w
R42		82283-84	68,000 ohms, ±10%, ½ w
R43		82283-163	1500 ohms, ±5%, ½ w
R44		82283-181	8200 ohms, ±5%, ½ w
R45		82283-94	470,000 ohms, ±10%, ½ w
R46		82283-175	4700 ohms, ±5%, ½ w
R47		82283-90	220,000 ohms, ±10%, ½ w
R48		82283-64	1500 ohms, ±10%, ½ w
R49		82283-133	82 ohms, ±5%, ½ w
R50	99671	8971860-104	variable, comp., 250 ohms, ±10%, 2 w
R51		82283-62	1000 ohms, ±10%, ½ w
R52		82283-86	100,000 ohms, ±10%, ½ w
R53		82283-62	1000 ohms, ±10%, ½ w
R54	205044	8971860-114	variable, comp., 100,000 ohms, ±10%, 2 w
R55, R56		82283-86	100,000 ohms, ±10%, ½ w
R57	102241	993008-101	wire wound, 10,000 ohms, ±5%, 10 w
R58		82283-135	100 ohms, ±5%, ½ w
R59		90496-82	47,000 ohms, ±10%, 1 w
R60		82283-64	1500 ohms, ±10%, ½ w
R61		82283-98	1 meg ±10%, ½ w
R62		99126-86	100,000 ohms, ±10%, 2 w
R63		82283-86	100,000 ohms, ±10%, ½ w
R64		82283-98	1 meg ±10%, ½ w
R65		82283-93	390,000 ohms, ±10%, ½ w
R66		82283-103	2.7 meg ±10%, ½ w
R67		99126-73	8200 ohms, ±10%, 2 w
R68			Not Used
R69		90496-62	1000 ohms, ±10%, 1 w
R70		82283-153	560 ohms, ±5%, ½ w
R71		90496-80	33,000 ohms, ±10%, 1 w
R72		82283-94	470,000 ohms, ±10%, ½ w
R73		82283-78	22,000 ohms, ±10%, ½ w
R74		82283-62	1000 ohms, ±10%, ½ w
R75		82283-70	4700 ohms, ±10%, ½ w
R76		82283-71	5600 ohms, ±10%, ½ w
R77		99126-79	27,000 ohms, ±10%, 2 w
R78		99126-78	22,000 ohms, ±10% 2 w
R79		90496-77	18,000 ohms ±10%, 1 w
R80		82283-100	1.5 meg ±10%, ½ w
R81		82283-98	1 meg ±10%, ½ w
R82		82283-82	47,000 ohms, ±10%, ½ w
R83		82283-98	1 meg ±10%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R84		82283-82	47,000 ohms, ±10%, ½ w
R85		82283-71	5600 ohms, ±10%, ½ w
R86		90496-79	27,000 ohms, ±10%, 1 w
R87		99126-78	22,000 ohms, ±10%, ½ w
R88		90496-77	18,000 ohms ±10%, 1 w
R89		82283-100	1.5 meg ±10%, ½ w
R90		82283-62	1000 ohms, ±10%, ½ w
R91		82283-207	100,000 ohms, ±5%, ½ w
R92		82283-86	100,000 ohms, ±10%, ½ w
R93		82283-82	47,000 ohms, ±10%, ½ w
R94		82283-159	1000 ohms, ±5%, ½ w
R95		82283-90	220,000 ohms, ±10%, ½ w
R96		82283-104	3.3 meg ±10%, ½ w
R97		99126-76	15,000 ohms, ±10%, 2 w
R98	99658	8971860-102	variable, comp., 100 ohms, ±10%, 2 w
R99	220197	990185-522	film, 165,000 ohms, ±5%, ½ w
R100	96535	993008-95	wire wound, 5000 ohms, ±5%, 10 w
R101		82283-88	150,000 ohms, ±10%, ½ w
R102		82283-69	3900 ohms, ±10%, ½ w
R103	93175	8971860-110	variable, comp., 10,000 ohms, ±10%, 2 w
R104		82283-62	1000 ohms, ±10%, ½ w
R105	211036	990185-618	film, 1.5 meg ±1%, ½ w
R106		99126-80	33,000 ohms, ±10%, 2 w
R107		82283-59	560 ohms, ±10%, ½ w
R108		82283-100	1.5 meg ±10%, ½ w
R109		82283-86	100,000 ohms, ±10%, ½ w
R110		82283-95	560,000 ohms, ±10%, ½ w
R111		82283-62	1000 ohms, ±10%, ½ w
R112, R113	98077	8971860-113	variable, comp., 50,000 ohms, ±10%, 2 w
R114		82283-80	33,000 ohms, ±10%, ½ w
R115		82283-198	43,000 ohms, ±5%, ½ w
R116, R117		82283-86	100,000 ohms, ±10%, ½ w
R118, R119		90496-111	10 ohms, ±5%, 1 w
R120		82283-94	470,000 ohms, ±10%, ½ w
R121			Part of XDS2
R122		82283-87	120,000 ohms, ±10%, ½ w
R123			Part of XDS1
R124		82283-86	100,000 ohms, ±10%, ½ w
R125		82283-189	18,000 ohms, ±5%, ½ w
R126		82283-98	1 meg ±10%, ½ w
R127	98077	8971860-113	variable, comp., 50,000 ohms, ±10%, 2 w
R128		82283-82	47,000 ohms, ±10%, ½ w
R129	213655	990185-389	film, 8250 ohms, ±1%, ½ w
R130	219197	990185-325	film, 1780 ohms, ±1%, ½ w
R131		82283-74	10,000 ohms, ±10%, ½ w
R132			Not Used
R133		82283-233	1.2 meg ±5%, ½ w
R134, R135		82283-62	1000 ohms, ±10%, ½ w
R136		82283-81	39,000 ohms, ±10%, ½ w
R137		82283-66	2200 ohms, ±10%, ½ w
R138		82283-93	390,000 ohms, ±10%, ½ w
R139		82283-74	10,000 ohms, ±10%, ½ w
R140		82283-132	75 ohms, ±5%, ½ w
R141		82283-56	330 ohms, ±10%, ½ w
R142		99126-52	150 ohms, ±10%, 2 w
R143, R144			Not Used
R145		82283-60	680 ohms, ±10%, ½ w
R146 to R148		82283-86	100,000 ohms, ±10%, ½ w
R149		82283-68	3300 ohms, ±10%, ½ w
R150, R151	219728	8945608-198	film, 33,200 ohms, ±1%, 2 w
R152		82283-233	1.2 meg ±5%, ½ w
R153		82283-225	560,000 ohms, ±5%, ½ w
R154		82283-67	2700 ohms, ±10%, ½ w
R155		90496-62	1000 ohms, ±10%, 1 w
R156	221703	8945608-201	film, 1.10 meg ±1%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R157,R158		82283-60	680 ohms, ±10%, ½ w
R159		90496-80	33,000 ohms, ±10%, 1 w
R160		82283-94	470,000 ohms, ±10%, ½ w
R161		82283-82	47,000 ohms, ±10%, ½ w
R162		90496-74	10,000 ohms, ±10%, 1 w
R163		82283-74	10,000 ohms, ±10%, ½ w
R164		82283-72	6800 ohms, ±10%, ½ w
R165		82283-92	330,000 ohms, ±10%, ½ w
R166		82283-86	100,000 ohms, ±10%, ½ w
R167,R168		82283-60	680 ohms, ±10%, ½ w
R169,R170	219728	8945608-198	film, 33,200 ohms, ±1%, 2 w
R171	212133	8971860-120	variable, 2.5 meg ±20%, 2 w
R172,R173	215169	990185-301	film, 1000 ohms, ±1%, ½ w
R174,R175		82283-98	1 meg ±10%, ½ w
R176	221703	8945608-201	film, 1.10 meg ±1%, ½ w
R177	97961	8971860-117	variable, 500,000 ohms, ±10%, 2 w
R178		82283-60	680 ohms, ±10%, ½ w
R179		82283-68	3300 ohms, ±10%, ½ w
R180		99126-82	47,000 ohms, ±10%, ½ w
R181		82283-102	2.2 meg ±10%, ½ w
R182		82283-50	100 ohms, ±10%, ½ w
R183		90496-74	10,000 ohms, ±10%, 1 w
R184		82283-60	680 ohms, ±10%, ½ w
R185		82283-93	390,000 ohms, ±10%, ½ w
R186		82283-55	270 ohms, ±10%, ½ w
R187		82283-169	2700 ohms, ±5%, ½ w
R188		82283-213	180,000 ohms, ±5%, ½ w
R189,R190		82283-86	100,000 ohms, ±10%, ½ w
R191		82283-94	470,000 ohms, ±10%, ½ w
R192		82283-55	270 ohms, ±10%, ½ w
R193		82283-213	180,000 ohms, ±5%, ½ w
R194		82283-169	2700 ohms, ±5%, ½ w
R195		82283-50	100 ohms, ±10%, ½ w
R196		82283-225	560,000 ohms, ±5%, ½ w
R197		82283-54	220 ohms, ±10%, ½ w
S1	59509	8861341-1	Switch
T1	204051	206468-2	Transformer: audio
T2	51936	895314-1	Transformer: coupling
T3,T4	58619	895326-4	Transformer: filament
T5	51936	895314-1	Transformer: coupling
TP1 to TP17	208983	8825493-7	Jack: tip, yellow
XADS1,XASD2	208080	990788-507	Jewel: indicator light
XDS1,XDS2	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XK1,XK2	9915	746008-8	Socket: relay 11 pin
XK3	68590	99100-4	Socket: relay 8 pin
XK4			Not Used
XK5,XK6	9915	746008-8	Socket: relay 11 pin
XV1,XV2	94925	737867-14	Socket: tube, 7 pin
XV3,XV4	94926	737870-14	Socket: tube, 9 pin
XV5,XV6	94925	737867-14	Socket: tube, 7 pin
XV7 to XV22	94926	737870-14	Socket: tube, 9 pin

VOLTAGE CHART — CAPSTAN SERVO

NOTE: Voltages taken with respect to chassis ground and with vacuum tube voltmeter (VTVM).
All voltages are dc unless otherwise noted.

Symbol	Mode	Pin Number								
		1	2	3	4	5	6	7	8	9
V1	PLAY	0 to .1**	4.2	GND	6.3AC	270	150	4.2	—	—
V2	PLAY	150	4.5	—	4.5	150	—	4.5	—	—
V3	PLAY	15.0	0	280	6.3AC	GND	280	15.0	280	0
V4	PLAY	280	—	80	GND	GND	165	—	1.75	6.3AC
V5	PLAY	+.1 to −1.2**	+.1 to −1.2**	GND	6.3AC	61.0	—	−14 to −14.4	—	—
V6	PLAY	0	0	GND	6.3AC	61.0	—	−13.5	—	—
V7	PLAY	280	−110	.35	GND	GND	275	+.5 to −1.0**	+.54**	6.3AC
V8	PLAY	280	29.0	41.5	GND	GND	29.0	−12.6	—	6.3AC
V9	PLAY	212	0	2.9	GND	GND	52.0	.83	1.5	6.3AC
V10	PLAY	−51.0	−172	−150	†	†	220	−51.0	−23	†
V11	SETUP	1.35	—	134	†	†	1.8	0	95.0	137
V12	PLAY	104	1.25	1.75	†	†	190	−.5	+.58	†
V13	PLAY	120	−26.5	25.0	†	†	245	4.2	25.0	†
V14	PLAY	−51.0	−170	−151	†	†	228	−51.0	−24.0	†
V15	PLAY	—	—	—	†	†	—	—	—	—
V16	PLAY	190	0	1.6	†	†	145	0	1.0	†
V17	SETUP	42.0	0	1.5	†	†	35.0	0	1.32	†
V18	PLAY	210	−45.0	.08	†	†	−45.0	*	−150	†
V19	PLAY	−34.0	−180	−150	†	†	187	−34.0	−5.5	†
V20	PLAY	275	−5.8	7.6	6.3AC	6.3AC	275	−16	—	GND
V21	PLAY	275	−48.0	−.63	6.3AC	6.3AC	275	*	125	GND
V22	PLAY	280	−.5	1.3	6.3AC	6.3AC	280	.8	0	GND
V23	PLAY	−.5 to −.6	—	GND	6.3AC	*	—	−21	—	—
V24	PLAY	−.63	−15.0	GND	6.3AC	−148	—	—	—	—

* Do not measure, servo system will lose lock.
** Fluctuates.
† −75 V to ground 6.3 V AC across filaments.

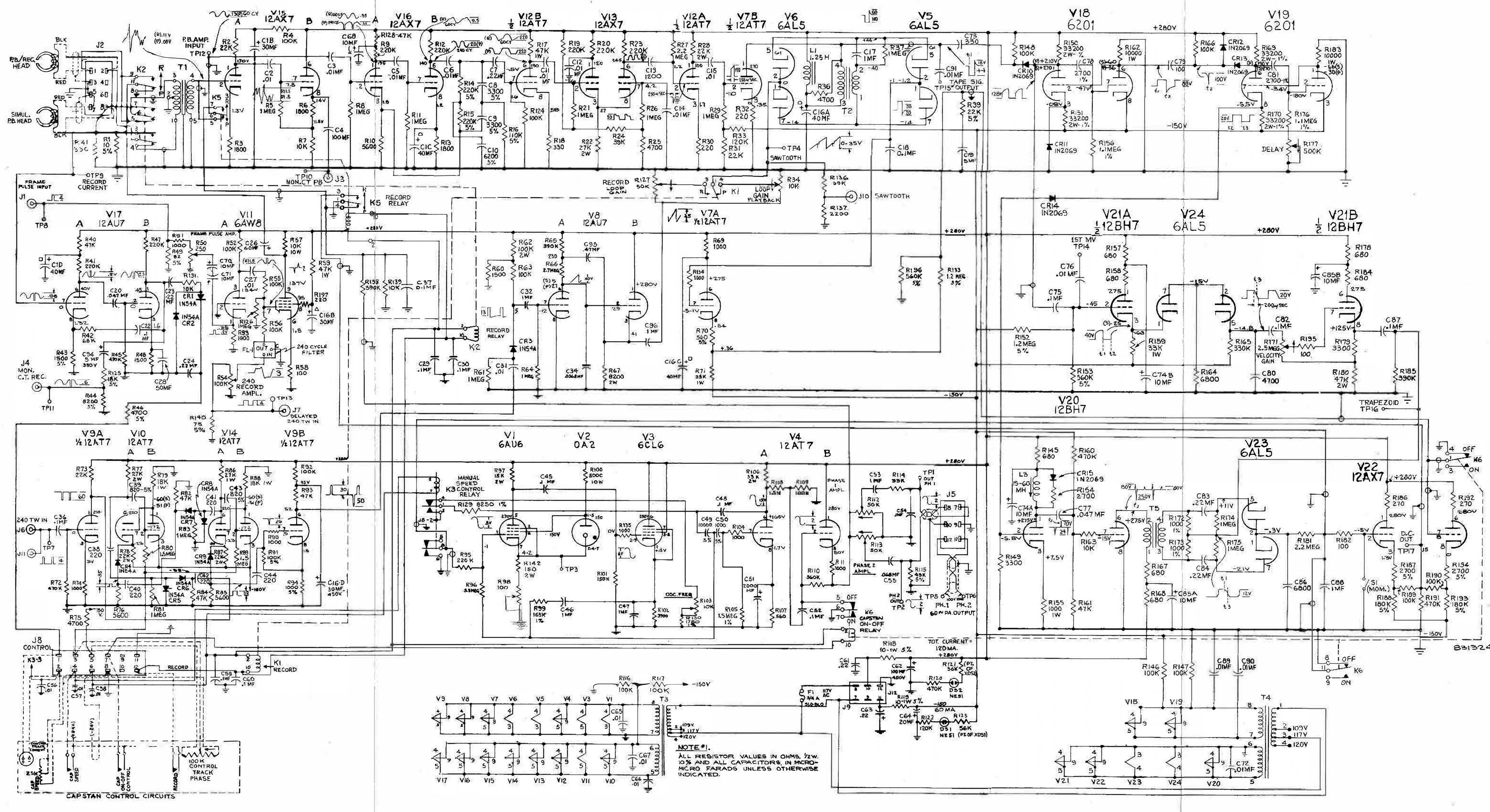


Figure CS-22. Schematic Diagram, Capstan Servo Chassis

ELECTRONIC RECORDING PRODUCTS

Reference Generator

UNIT 407

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
PP 651

IB-31149

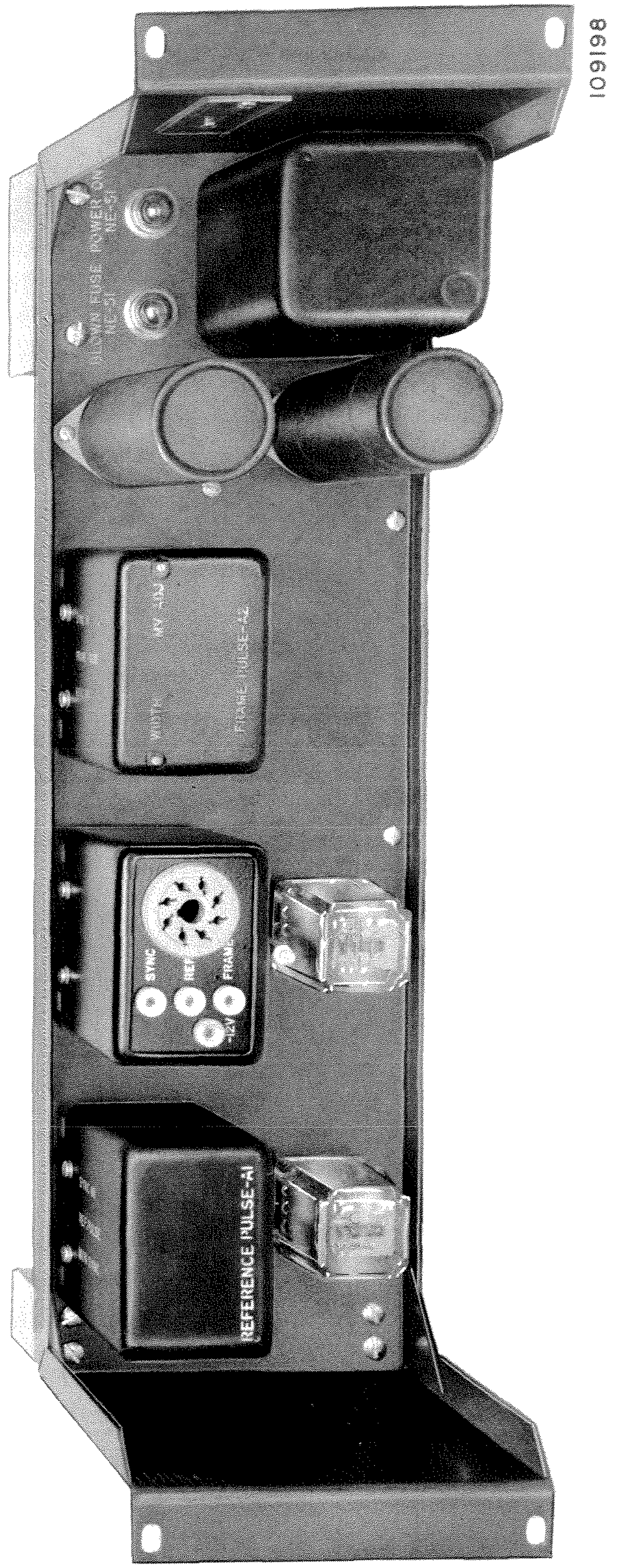


Figure RG-1. Reference Generator

TECHNICAL DATA

Power Required

117 V AC, 60 cycles, .180 amp, 21 watts from C.B. #4 (with taps for 105v or 125v)

Outputs

Reference Pulse: −4v ± .5v, 60 pps, 260 microseconds wide (±50)

Sync for Picture Monitor 103: −3.75v ± .5v

Frame Pulse: +4v ± .5v, 30 pps, 60 microseconds wide (adjustable)

Inputs

Separated Sync: −4v ± .5v

Local Sync: −4v ± .5v

Fuse

½ amp, 3AG slo blo

Lamps

2 NE-51

Transistor and Diode Complement

1	2N581	1	1N1524A
1	2N582	1	1N461
4	2N585	3	1N2096
2	2N404	9	1N96

DESCRIPTION

The Reference Generator, unit 407, provides the System with the main timing reference pulse of 60 pps which is used in the Headwheel Servo, unit 504, to control the speed of the headwheel motor in either RECORD or PLAYBACK mode of operation. In the RECORD mode of operation, the Reference Generator also provides a 30 pps frame pulse which is added to the control track signal in the Capstan Servo, unit 404, and recorded on the tape to indicate the proper cutting point in tape splicing operations.

As shown in figure RG-1, three modules are plugged into the generator chassis. Module A1 provides the reference pulse and a sync output signal for the Picture Monitor, unit 103. Module A2 provides the 30 pps frame pulse. Test Module A5, mounted in the center, mounts either Module A1 or A2 at a convenient distance from the chassis for testing and servicing.

The Reference Generator, unit 407, connects into the system as follows:

Reference Generator		*System Unit*		
Output	*Designation*	*Unit*	*Designation*	*Input*
J10	60 REF OUT	Headwheel Servo (504)	REF PULSE	J1
J11	FRAME PULSE OUT	Capstan Servo (404)	FRAME PULSE INPUT	J1
J12	MON SYNC OUT	Picture Monitor (103)	EXT SYNC	J3
Input	*Designation*	*Unit*	*Designation*	—
J8*	SEP SYNC IN	2 X 1 Switcher (309)	SYNC OUT	J8 (Output)
thru J9	Loop thru to →	Burst Oscillator (605) (Color System)	SYNC IN	J2 (Input)
J7*	LOCAL SYNC IN	Local Station Equipment	SYNC	Output
thru J6	Loop thru to →	CRO Waveform Monitor (308)	EXT SYNC	Input

* J9 and J6 are spare jacks for bridging the line to supply sync to other system units or for 75-ohm termination.

Circuit Description

The Reference Generator consists of two pulse forming modules, A1 and A2, a Test Module A5, two relays K1 and K2, a self-contained power supply and a transistor circuit to invert the frame pulse. Refer to figure RG-17 for the chassis schematic.

In the RECORD or SETUP mode of operation, selected on the System Control Panel, relay K1 is normally energized and selects separated sync as the primary timing waveform. On the System Control Panel, this selection is made by the RECORD LOCK switch, position SIG-SYNC. However, local sync may be selected by this same switch, position GEN SYNC, when it seems desirable because several program sources are being used. With local sync selected, relay K1 is deenergized; relay K2 is always deenergized in the record mode of operation.

In the PLAYBACK or STANDBY mode of operation, selected on the System Control Panel, relay K1 is deenergized and selects local sync to appear at Module A1 for generation of a monitor sync output. Relay K2 is deenergized when local sync is selected for timing of the reference pulse. On the System Control Panel, this selection is made by the PLAYLOCK switch, position GEN SYNC. When local sync is not available or the local sync generator may have failed, line sync may be selected by the PLAYLOCK switch, position LINE SYNC. In this position, relay K2 is energized. The reference pulse is then triggered directly from the reference generator 60-cycle power line. The 60-cycle sine wave voltage is applied to a pulse forming network, diodes CR5 and CR6 and resistor R11 and capacitor C8. The output trigger pulse from the power line pulse-forming network is then applied directly to the multivibrator of Module A1.

Module A1

As shown in the schematic diagram for Module A1, figure RG-17, the sync input signal is applied to the base of the emitter follower Q1 through diode CR1. This diode, biased through R1 in the base circuit keeps the transistor from loading down the input sync line when power is removed. The sync output from the first stage Q1 supplies approximately 3.75 volts of sync to the Picture Monitor, unit 103, and to the frame pulse generator Module A2. The same pulse is applied to the sync separating circuit L1, C2, R3, which simultaneously differentiates, integrates and sums the integral and differential.

Due to the differentiating action, sharp spikes appear at the leading and trailing edges of the horizontal sync pulses, equalizing pulses and vertical pulses. Because of the integration and summation of the two, the spikes are offset during the vertical sync pulse interval. Observe the waveform in figure RG-14D. Network R14 and CR2 sets the level so that only the negative going spikes during the vertical sync pulse interval have sufficient amplitude to trigger the reference pulse multivibrator, Q2 and Q3. This multivibrator, a complementary-symmetry monostable type, drives the coax output line directly. In the stable or untriggered state, both transistors are cutoff; in the triggered state, both are driven to saturation by the first negative spike in the vertical pulse interval which coincides with the leading edge of the second vertical pulse. The width of the pulse is determined primarily by the time constant R8 and C3. The collector load of Q3 is the 75-ohm coaxial line-termination. Transistor Q3 acts as a switch which connects the −4 volt supply to the 75-ohm termination to produce a −4 volt output or reference pulse, 260 microseconds in width, 60 pps.

Module A2

In the Module A2, the sync signal from Module A1 is applied through the differentiating network R1 and C1 and the steering diode CR1 to the base of Q1. Only negative spikes are transmitted through CR1. In the monostable multivibrator Q1 and Q2, Q1 is conducting and Q2 is cutoff in the stable state. The duration of this stable state is determined by the time constant C3 in series with R4 and R6. The time constant is adjusted by R5, MV ADJ, so that Q1 remains cutoff slightly more than half of the horizontal period. The multivibrator triggers with every horizontal sync pulse and only with alternate equalizing pulses or vertical serrations. Therefore, the multivibrator triggers at the leading edge of the first vertical sync pulse on field one and at the leading edge of the second vertical sync pulse on field two. The silicon diode CR3 provides temperature stabilization of the multivibrator by preventing the current Icbo, which varies with temperature, from flowing into the timing capacitor C3. Instead, the current flows into R3 at high temperature. The germanium diode CR2 provides a path for R3 current at low temperatures.

The multivibrator output at the collector of Q2 is differentiated by C6 and R13, and the positive spike is clipped by CR5. This signal, consisting of a series of negative spikes, is applied to CR4, one input of the coincidence circuit. The reference pulse is differentiated by C7, R26 and applied to CR6, the other input of the coincidence circuit. When two negatives are applied simultaneously to the coincidence gate, CR4 and CR6, a negative output pulse is provided. This coincidence occurs at the leading edge of the second vertical sync pulse of field #2 (refer to figure RG-2) providing a negative 30 pps pulse. The steering diode CR7 blocks the positive spike which occurs at the trailing edge of the reference pulse and passes the 30 cycle negative trigger to the base of transistor Q3.

The monostable, complementary-symmetry multivibrator, Q3 and Q4, is similar to the multivibrator in the Module A1. Normally off, Q3 and Q4 are triggered on by the negative trigger output of the coincidence circuit. The frame pulse output from Q4 is a negative pulse at a 30 cycle rate which is set, approximately, to a 60-microsecond width, by the adjustment of R24, WIDTH control. This pulse is inverted by transistor Q1, mounted on the chassis, to provide a positive frame pulse output from the Reference Generator.

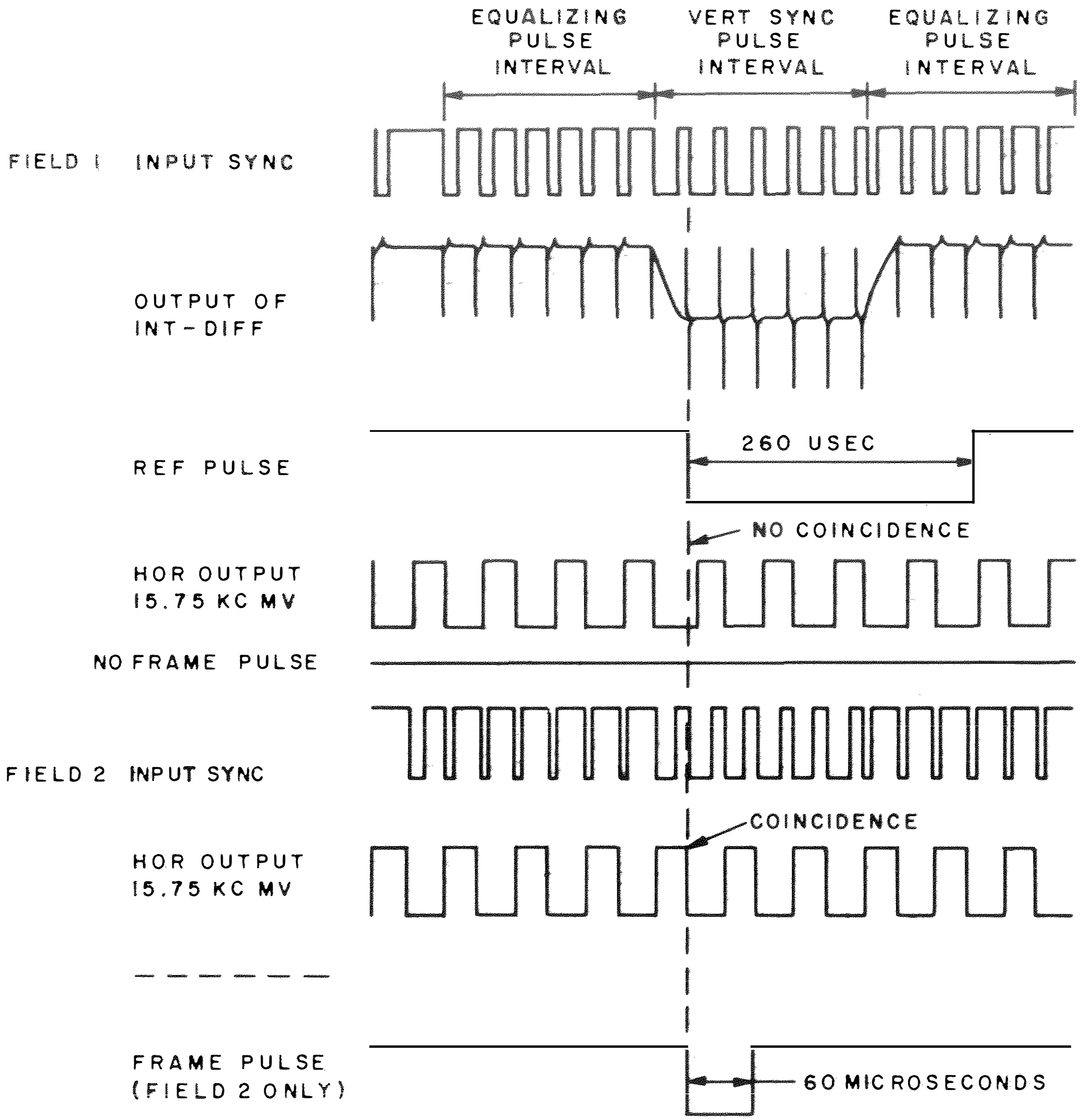


Figure RG-2. Frame Pulse Timing

Test Module A5

The Test Module consists of two octal sockets wired together and mounted so as to bring four test points above the surface of the chassis for convenience in testing the overall performance or servicing the modules. Refer to the *Maintenance* section for the procedures. Figure RG-3 shows the wiring of the sockets, pin for pin. The test module connections to the relays, the two modules and chassis mounted components are shown in figure RG-17.

Power Supply

The Zener diode CR1 regulates the power supply to −12 volts. The output of the rectifier CR4 is RC filtered by capacitors C1, C2, C3 and resistors R6, R7. With the exception of C1 and C2, these components are mounted on a small terminal board secured to the rear of the reference generator chassis. Refer to figure RG-4. The components, mounted on the terminal board and on the chassis and sockets, may be easily identified. Relays K1 and K2 are plug-in types which makes them easily accessible for trouble shooting, and have plastic covers keeping them free from dust. The relays, the transistor Q1 and related components are easily identified and have been covered in ther functional relation to the modules.

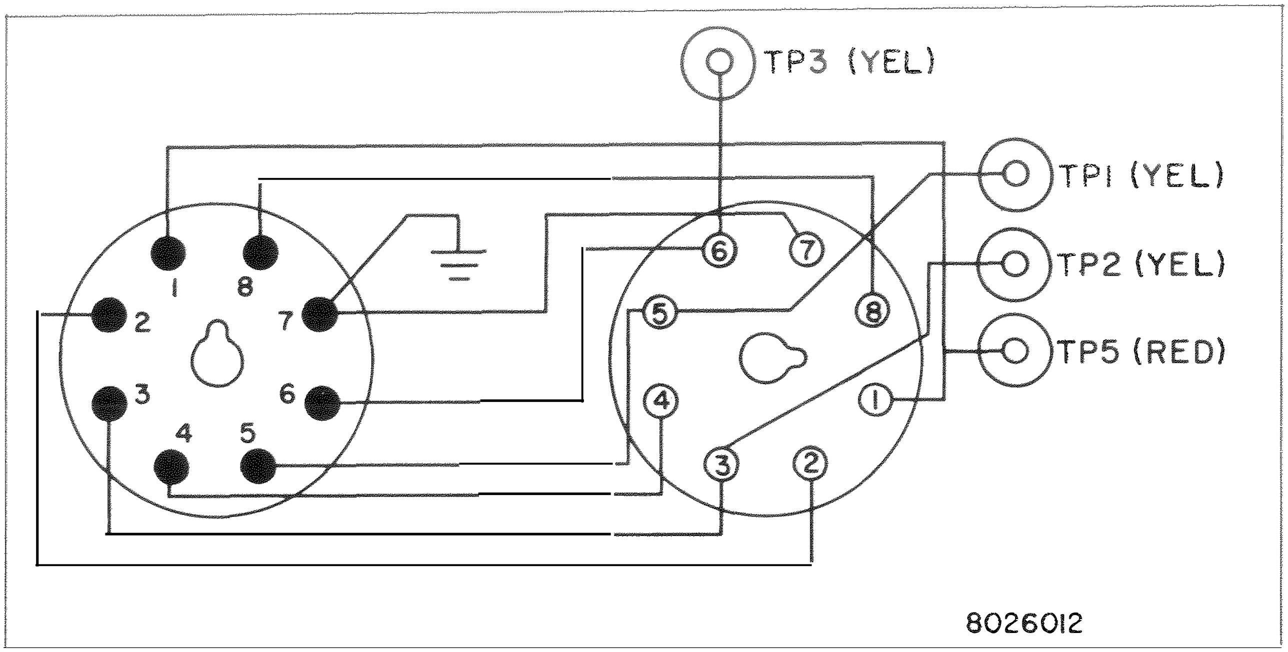


Figure RG-3. Wiring Diagram for Test Module A5

SETUP FOR OPERATION

The Reference Generator (407) is mounted in Rack 4. Once installed, the operation of this unit consists primarily of checking for satisfactory performance.

With the system in the SETUP position, before selecting RECORD or PLAYBACK mode, check for the presence of a reference pulse by pressing the REF PULSE pushbutton on the CRO/Monitor Switcher, unit 307. A waveform such as is shown in figure RG-5B should appear on the CRO Waveform Monitor, unit 306. If no pulse appears, check the Reference Generator referring to the procedures in the *Maintenance* section.

With the presence of a reference pulse assured, select the mode and application of the reference generator desired from the system control panel. In the RECORD mode, the RECORD LOCK toggle switch provides a choice of sync; in the PLAYBACK mode, the PLAY LOCK toggle switch provides a choice of sync. The following chart indicates the reference generator functions corresponding to the System Control Panel designations:

System Control Panel		*Reference Generator*	
Mode	*Sync Selector*	*Sync Selector*	*Relays*
RECORD or SETUP	RECORD LOCK: SIG SYNC ↑↓ GEN SYNC	Separated Sync Local Sync	K1 energized; K2 deenergized K1 deenergized; K2 deenergized
PLAYBACK or STANDBY	PLAY LOCK: GEN SYNC ↑↓ LINE SYNC	Local Sync Line Sync	K1 deenergized; K2 deenergized K1 deenergized; K2 energized

The following charts may be used for reference when making a pre-operating check of the system or when checking the reference generator for routine maintenance.

REFERENCE GENERATOR CHASSIS (FRONT)

Designation	*Symbol*	*Function*
Test Module		
SYNC	TP1 (Yel)	Test point for checking the input sync
REF	TP2 (Yel)	Test point for checking the reference pulse
FRAME	TP3 (Yel)	Test point for checking the frame pulse
−12V	TP4 (Red)	Test point for measuring the power supply output DC voltage
Module A1 (Mounted on Test Module)		
SYNC IN	TP1	Test point for checking sync input
REF PULSE	TP2	Test point for checking the reference pulse
MON SYNC	TP3	Test point for checking the sync output
Module A2 (Mounted on Test Module)		
SYNC IN	TP1	Test point for checking sync input
FRAME PULSE	TP2	Test point for checking frame pulse in module A2
HORIZ MV	TP3	Test point for checking 15.75 kc multivibrator pulse
Adjustments on Module A2		
WIDTH	R24	Screwdriver adjustment; adjusts width of frame pulse as viewed on oscillosocpe, TP2
MV ADJ	R5	Screwdriver adjustment; adjusts multivibrator Q1 as viewed on oscilloscope, HORIZ MV, TP3
Chassis		
POWER ON	DS1 NE-51	Indicator glows when power is ON
BLOWN FUSE	DS2 NE-51	Indicator glows when fuse has blown

REFERENCE GENERATOR CONNECTORS (REAR CHASSIS)

Symbol	*Location*	*Function*
J1	Chassis	For mounting Module A1 on chassis
J2	Chassis	For mounting Module A2 on chassis
J5	Chassis	For mounting Test Module A5 on chassis
J6 LOC SYNC	Rear RH Bracket	Input for sync signal from local station auxiliary equipment
J7 LOC SYNC	Rear RH Bracket	Spare jack for bridging line to supply sync to other equipment such as the CRO (306) or for 75-ohm termination
J8 SEP SYNC	Rear RH Bracket	Input for separated sync signal from the 2 x 1 Switcher (309)
J9 SEP SYNC	Rear RH Bracket	Spare jack for bridging line to supply sync to other equipment or for 75-ohm termination
J10 REF PULSE	Rear LH Bracket	Output of Module A1 (P1-3)
J11 FRAME PULSE	Rear LH Bracket	Output of Module A2 (thru Q1-C)
J12 MON SYNC	Rear LH Bracket	Output of Module A1 (P1-6)
J13	Rear LH Bracket	6-contact receptacle or AC Cord plug; pins 9-11 to relay K1; pins 9-10 to relay K2; pin 12 to ground; pins 7-8 to AC outlet

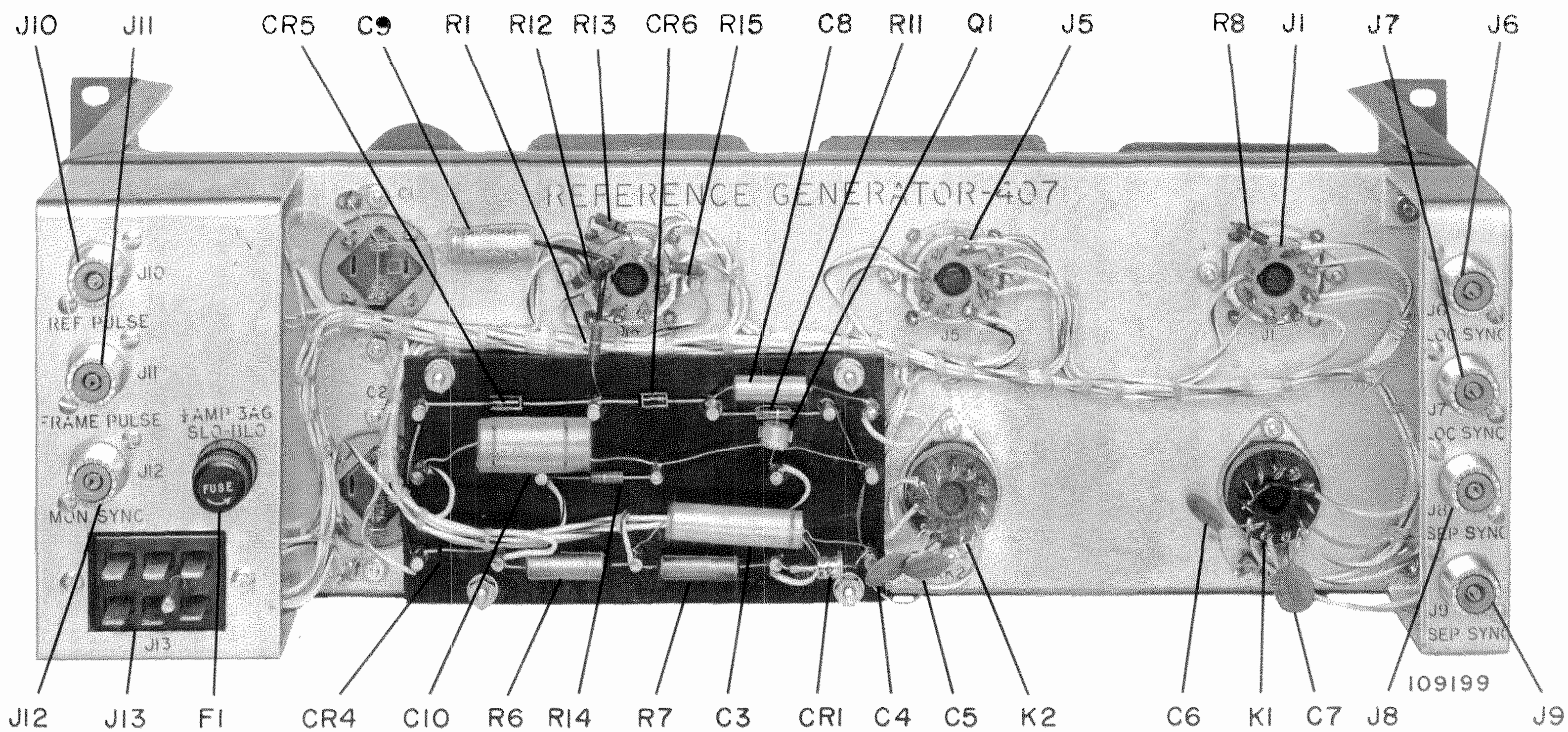


Figure RG-4. Reference Generator Rear View (Photo 109199)

MAINTENANCE

The Reference Generator is designed to be adjusted and serviced conveniently while installed in a rack. During a routine check of the system, check the test points of the Test Module and connect the Type 535 oscilloscope according to the individual procedures given for each module and for the chassis. Components may be easily replaced on the chassis; the plug-in module units are easily removed if further servicing should be necessary.

Replacement of Fuse

The indicator light DS2 glows when the fuse F1 is blown. Be sure to replace with a fuse of equivalent rating, 3AG ½ amp slo blo.

Replacement of Transistors

When a defective transistor is indicated, be sure to observe all of the following precautions for the removal and replacement of transistors:

1. Remove power before removing or replacing a transistor.
2. Avoid improper insertion of the replacement transistor.
3. AVOID EXCESSIVE HEAT.
4. Use a small soldering iron.
5. DO NOT USE RX1 scale of the ohmmeter; junction could be damaged.
6. Avoid accidental short circuits. Note that there is no warning of a short as in the tube circuits.

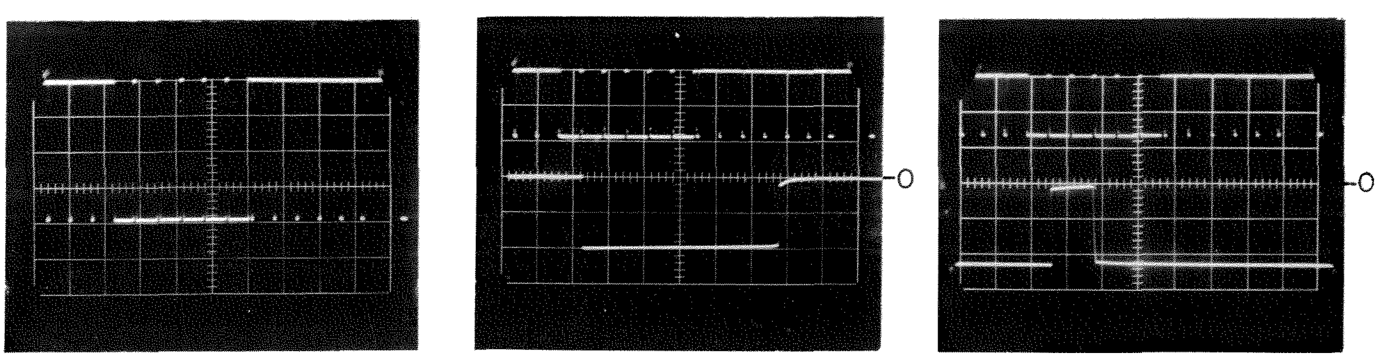
Setup for Type 535 Oscilloscope

All of the illustrations showing the waveforms (with one exception, figure RG-7), taken at designated test points on the reference generator as well as point to point checking of each module, were made with the Type 535 oscilloscope set up as follows:

1. Place the Tape System in the SETUP position on the Control Panel, unit 305.
2. Check to assure the presence of a reference pulse; if a reference pulse is available, connect the reference pulse output P1-3 to the EXT SYNC on the scope. (*If no reference pulse appears,* trigger the oscilloscope with sync.)
3. Trigger the B Channel trace.
4. Use the A DELAYED B position to expand the B trace to show detail and timing.
5. Set the A TIMING to 50 microseconds.
6. In most cases, a dual trace preamp is used so that input sync is displayed as a timing reference at the top of the photograph. The second input is set to the DC position and a voltage reference for that signal only is indicated in the photograph.

Checking Test Module A5

The Test Module is supplied to facilitate overall testing of the reference generator. This plug-in type module is normally seated in the octal socket between Module A1 and Module A2 on the reference generator chassis as shown in figure RG-1. In this position the four test points are easily available above the chassis surface. With the oscilloscope Type 535 connected as stated in the paragraph *Setup for Type 535 Oscilloscope,* the waveform at test points TP1, TP2, and TP3 should be as shown in figure RG-5.



A. TP-1 SYNC 1v/division. **B. TP-2 REF 2v/division.** **C. TP-3 FRAME 2v/division.**

Figure RG-5. Waveforms at Test Points on Test Module A5

Checking Modules A1 and A2

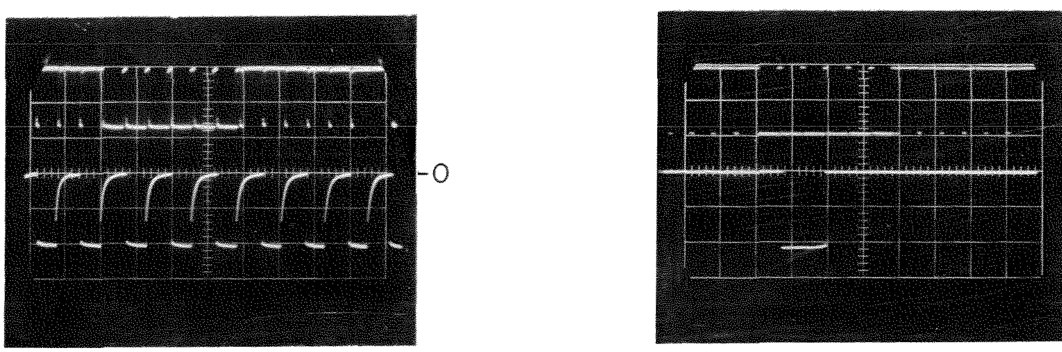
For checking Modules A1 and A2, the Test Module serves as a platform, elevating and rotating the module 90 degrees, as shown in figures RG-5 and -6. Remove the module to be tested and insert the Test Module in the empty socket; then plug the selected module into the test module, rotating the unit 90 degrees so that the designation for the test points on the test module are covered. The three designations on the cover of each module now line up with each test point. For point to point checking or replacement of parts while in this position, the cover may be removed by removing the four screws securing it to the module base plate. Refer to figures RG-10 and -12.

For Module A1, the waveforms for each of the functions designated on the side of the cover are shown in figure RG-11. For point to point checking including related chassis components, the waveforms are shown in figure RG-14. Relay sockets and all jacks may be easily reached from the rear of the reference generator chassis as shown in figure RG-4.

For Module A2, the waveforms for each of the functions designated on the cover are shown in figure RG-13. Waveforms for the MV ADJ and WIDTH adjustments are shown in figure RG-6. For point to point checking including related chassis components, the waveforms are shown in figures RG-15 and RG-16.

Playback with Locked Line Sync

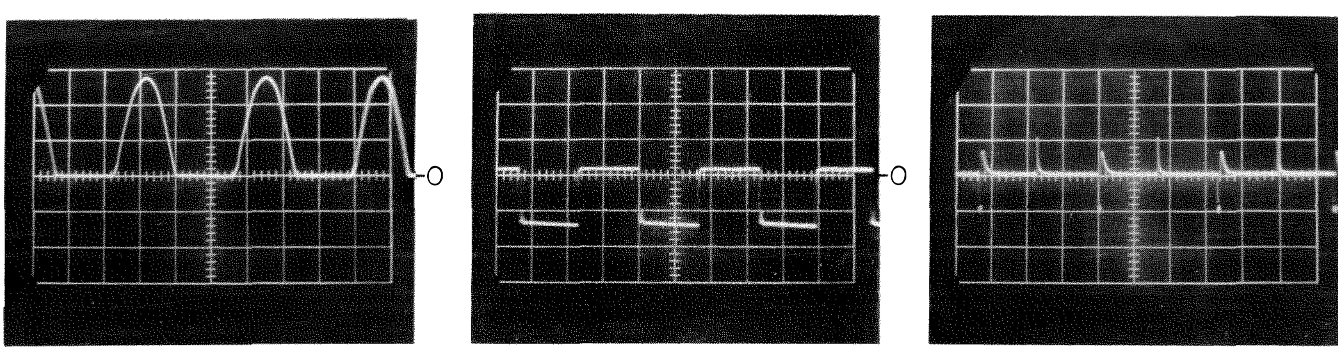
When the PLAYBACK mode is selected with LINE SYNC on the System Control Panel, unit 305, the sync input comes from the generator self-contained power supply through the pulse forming network to P1-4 of Module A1. The waveforms shown in figure RG-7 were observed with the Type 535 oscilloscope changed from the A DELAYED B position to the B only position and with B TIMING set at 5 milliseconds. The oscilloscope was triggered internally from LINE.



A. P2-6 MV ADJ 2v/division.

B. P2-3 WIDTH 2v/division.

Figure RG-6. Waveforms for MV ADJ and WIDTH Adjustments of Module A2



A. On R.G. cathode of CR5, CR6; 20v/division; oscilloscope at 5 microseconds, LINE.

B. On R.G. anode of CR6; 1v/division; oscilloscope at 5 microseconds, LINE.

C. On R.G. relay K2-3, .5v/division; oscilloscope at 5 microseconds, LINE.

Figure RG-7. Waveforms for Checking Reference Generator in PLAYBACK, LINE Operation

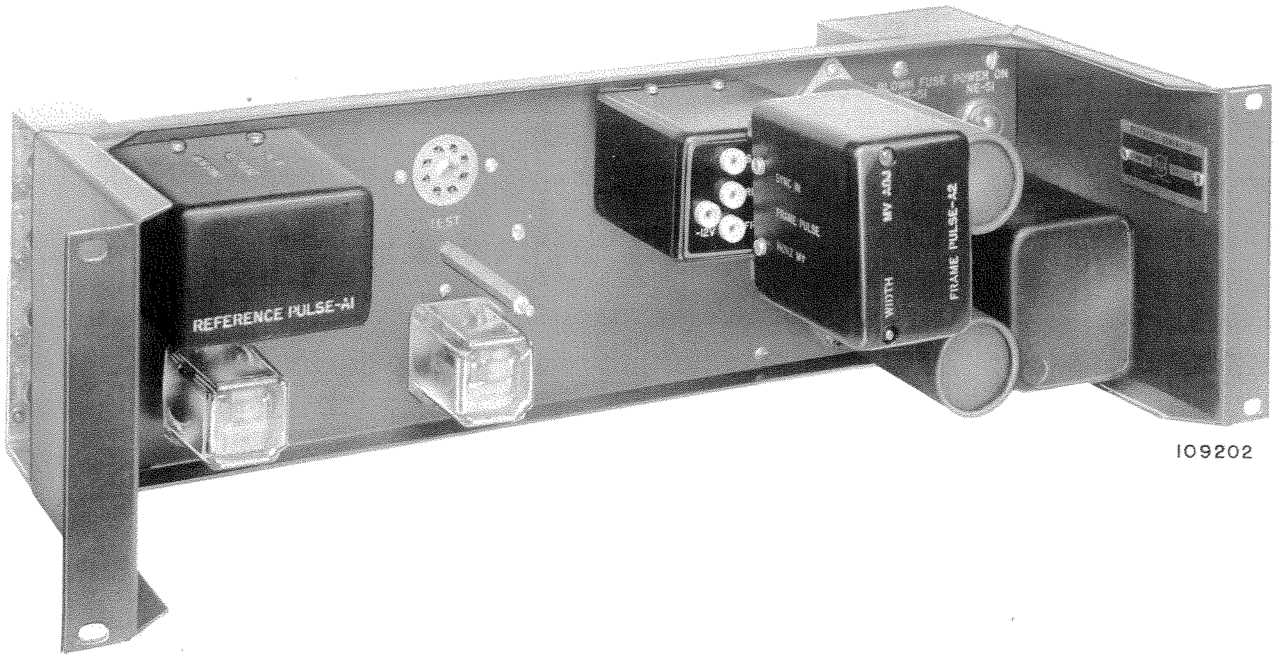


Figure RG-8. Test Module A5 in Position for Testing Module A2

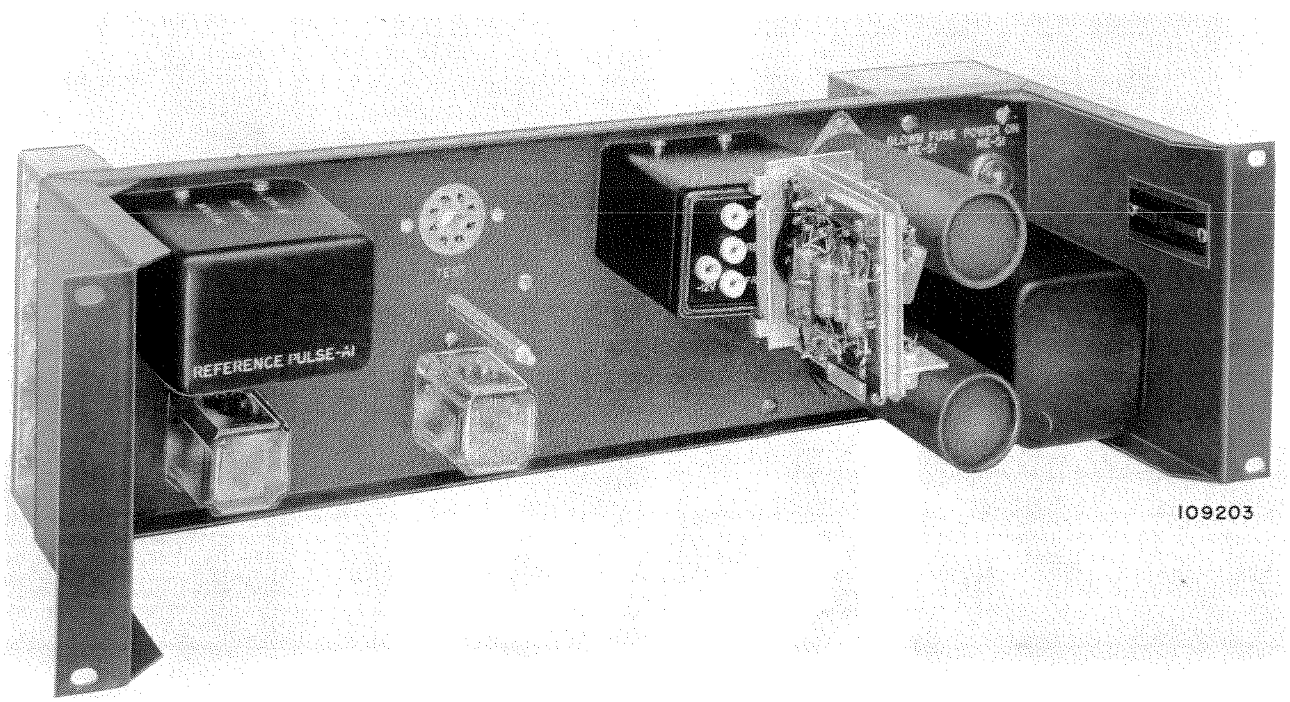


Figure RG-9. Test Module in Position for Testing Module A2 with Cover Removed

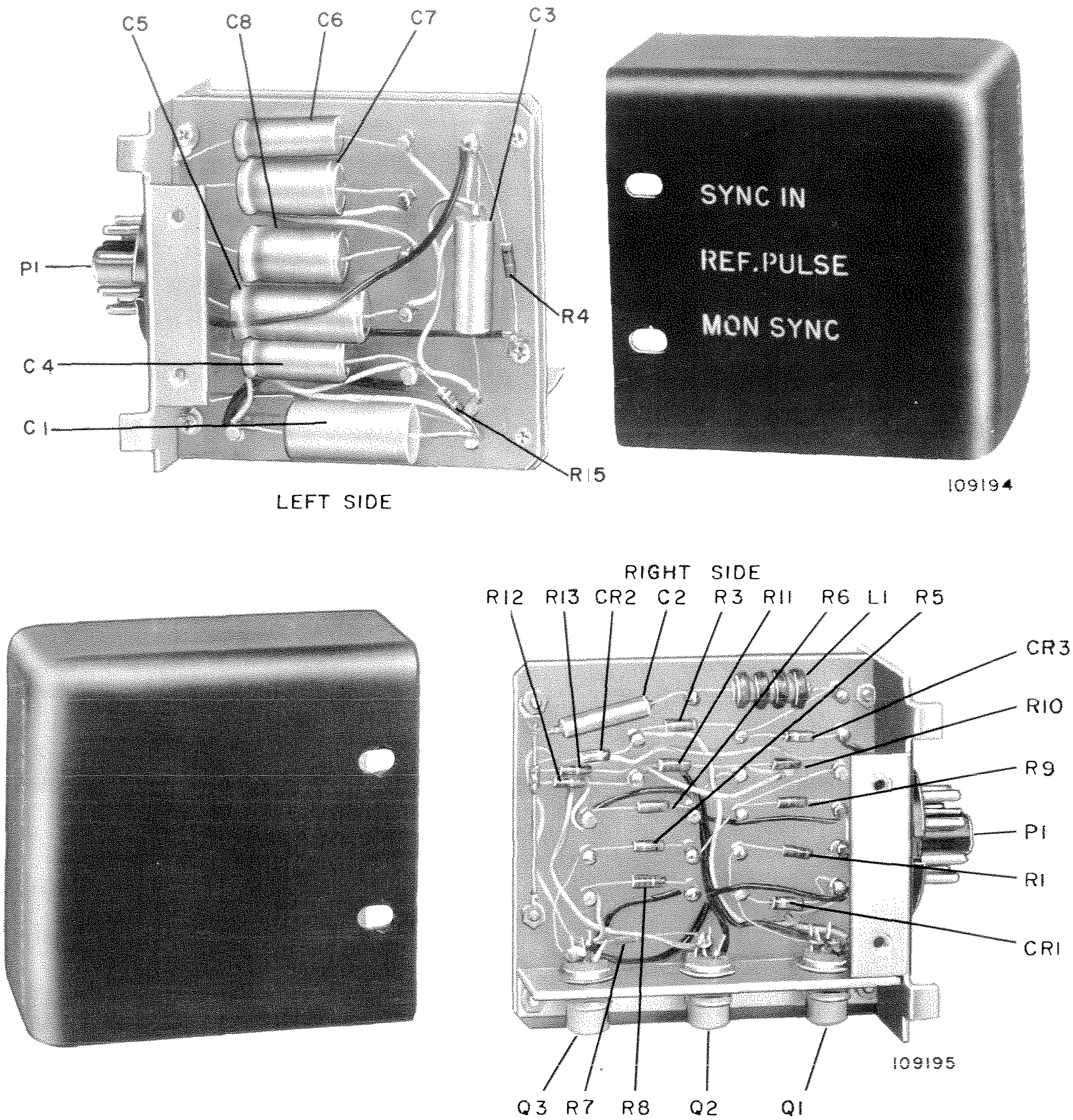
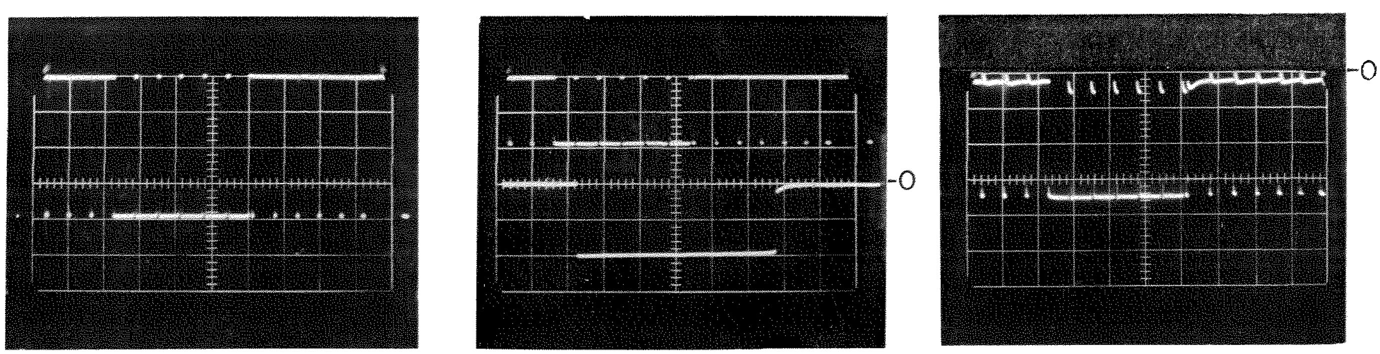


Figure RG-10. Module A1 with Cover Removed



A. TP-1 SYNC IN 1v/division.

B. TP-2 REF 2v/division.

C. TP-3 MON SYNC 1v/division.

Figure RG-11. Waveforms at Test Points for Module A1

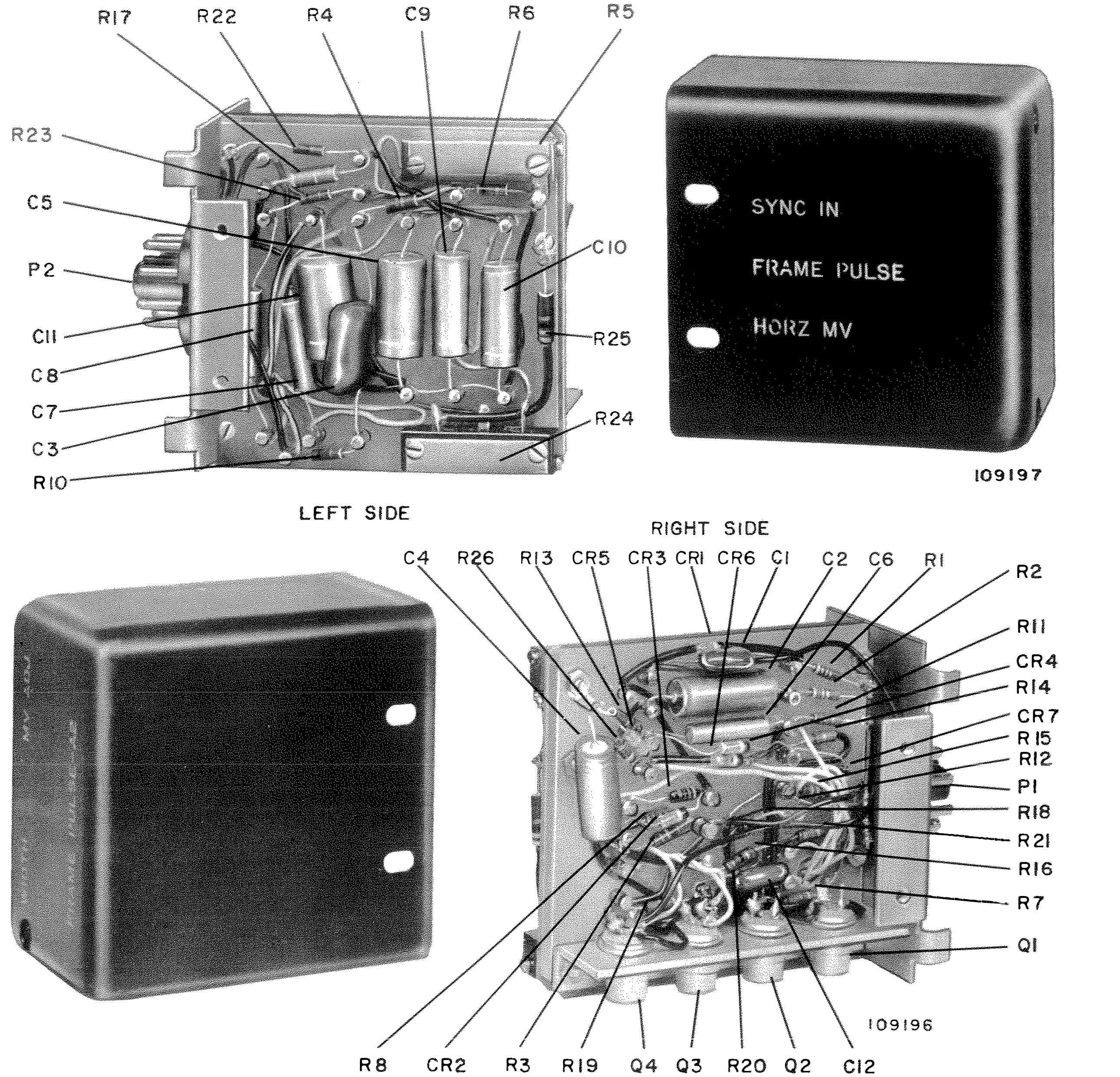
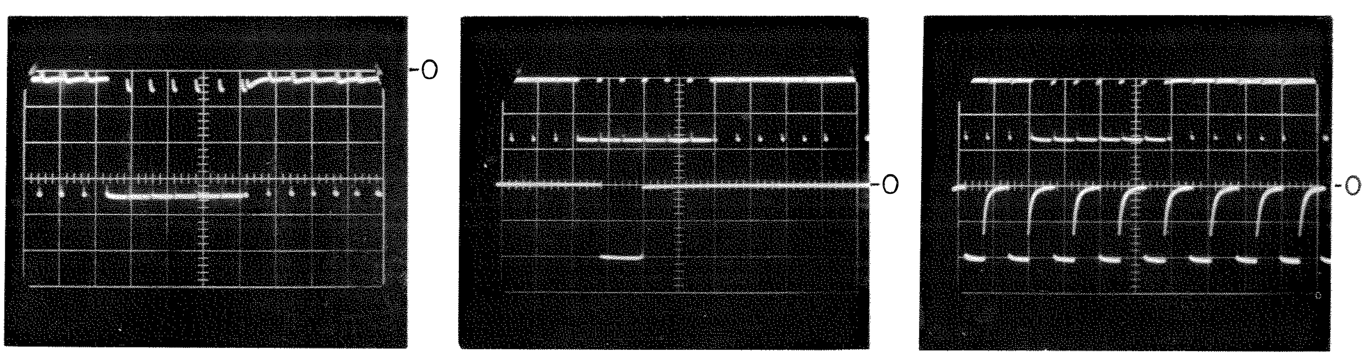
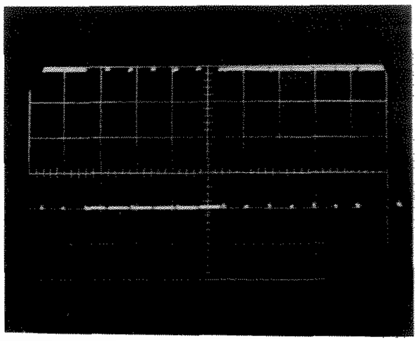


Figure RG-12. Module A2 with Cover Removed

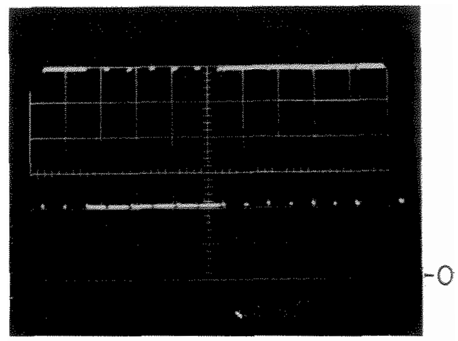


A. TP-1 SYNC IN 1v/division. **B. TP-2 REF 2v/division.** **C. TP-3 MON SYNC 1v/division.**

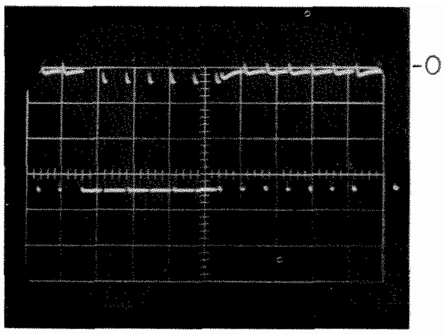
Figure RG-13. Waveforms at Test Points for Module A2



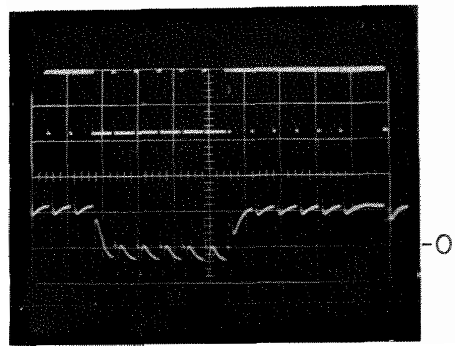
A. Local Sync at J6/J7; SYNC IN at A1, P1-5, 1v/division.



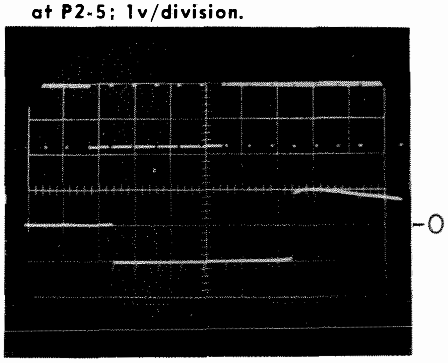
B. At Q1-B on Module A1, 1v/division.



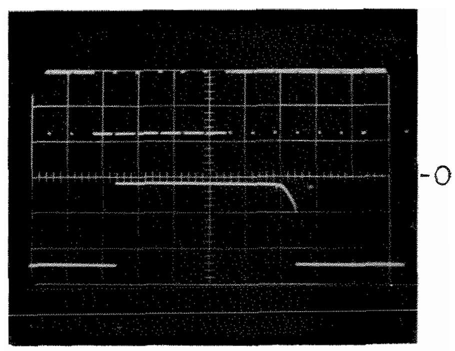
C. On A1 at Q1-E; MON SYNC OUT at P1-6 on A5, P5-4, J1-4; on R.G., MON SYNC OUT at J12; SYNC IN on A2 at P2-5; 1v/division.



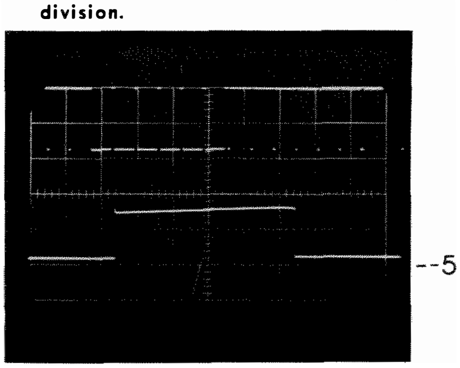
D. At cathode of CR3, 2v/division.



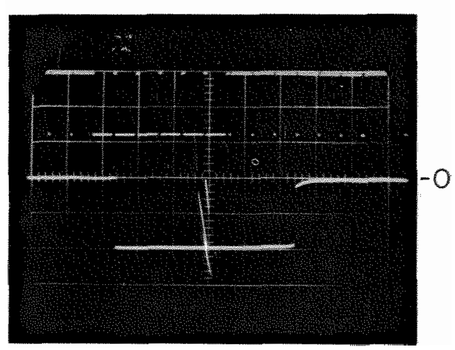
E. On A1, anode of CR3; plug P1-8 and P1-4 (thru K2); base of Q2; .5v/division.



F. On A1, collector of Q2; 2v/division.

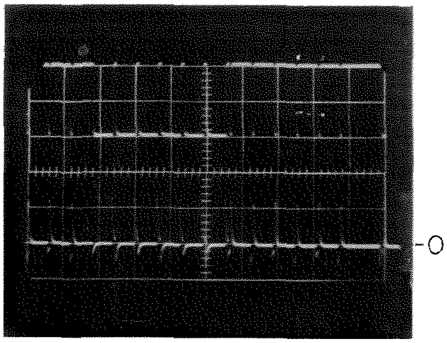


G. On A1, base of Q3; 1v/division.

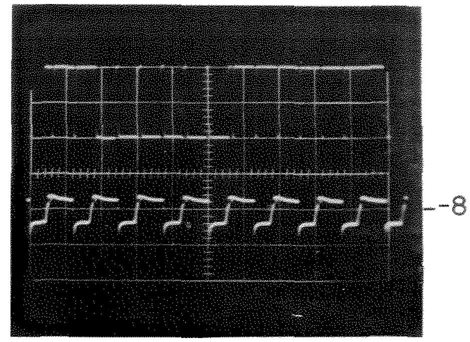


H. On A1 collector of Q3, REF PULSE OUT P1-3; on A5, P5-3/J1-3; on R.G. REF PULSE J10; 2v/division.

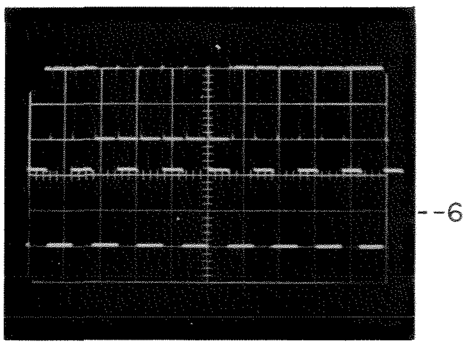
Figure RG-14. Waveforms for Point to Point Checking of Module A1 Including Related Chassis Components



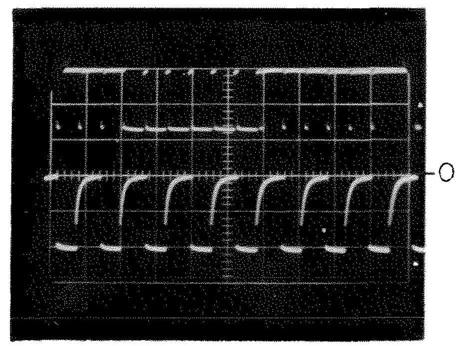
A. On A2, cathode of CR1; 2v/division.



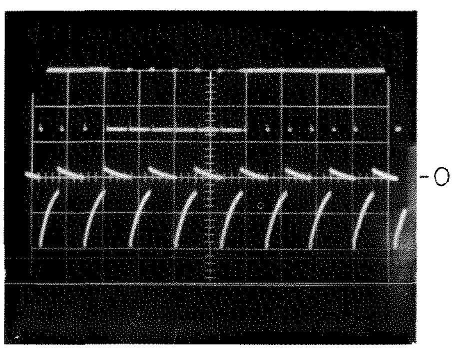
B. On A2, bose of Q1; .5v/division.



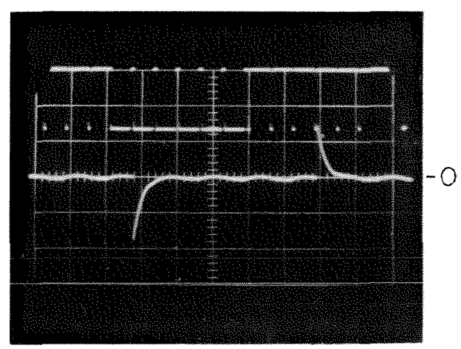
C. On A2, collector of Q1 and base of Q2; 2v/division.



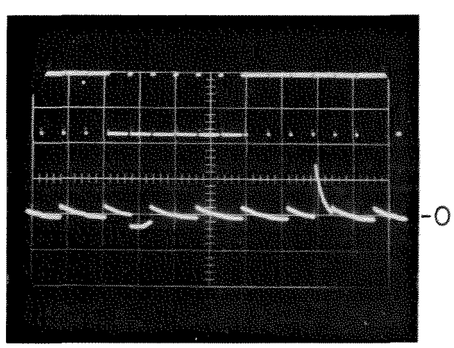
D. On A2, collector of Q2 and plug P2-6, MV ADJ; 2v/division.



E. On A2, onode of CR4; 2v/division.

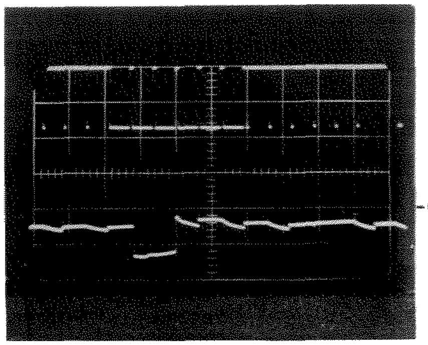


F. On A2, onode of CR6; 2v/division.

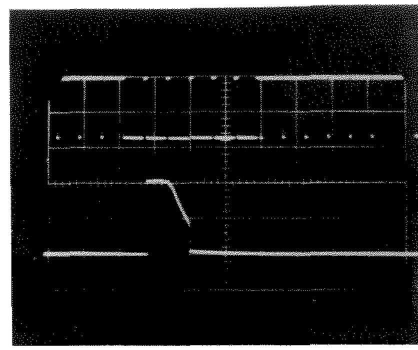


G. On A2, cathodes CR4, CR6 and CR7; 2v/division.

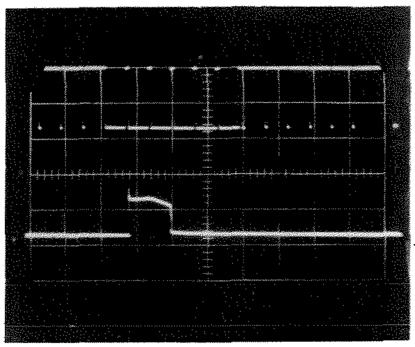
Figure RG-15. Waveforms for Point to Point Checking of Module A2 Including Related Chassis Components



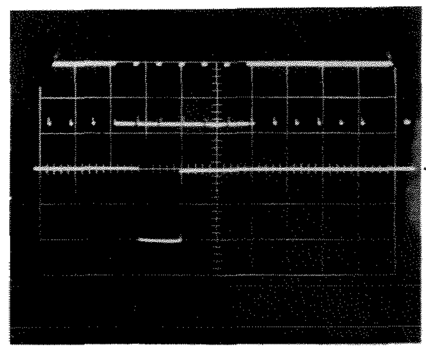
H. On A2, anode of CR7 and base of Q3; .5v/division.



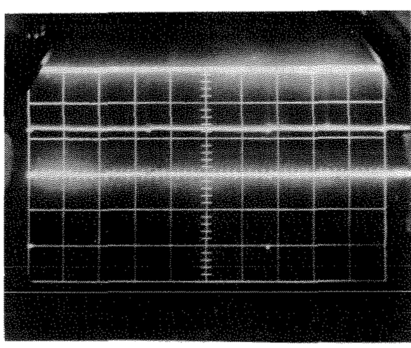
I. On A2, collector of Q3; 2v/division.



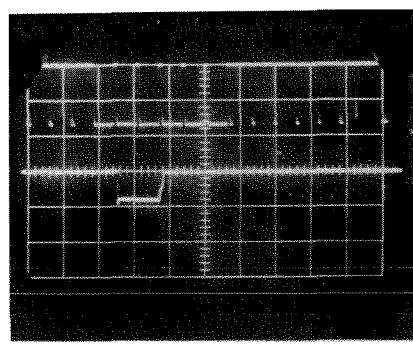
J. On A2, base of Q4; 1v/division.



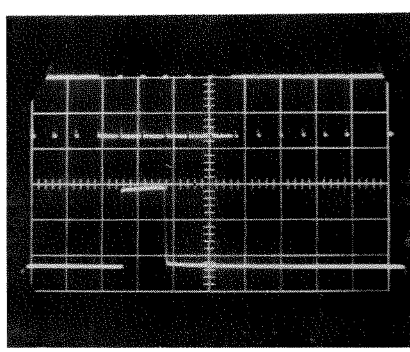
K. On A2, collector of Q4 and plug of P2-3 FRAME PULSE OUT; 2v/division.



L. On A2 at plug P2-3 with oscilloscope A TIMING set at 5 microseconds; 2v/division.



M. On R.G. base of Q1; .5v/division.



N. On R.G. collector of Q1 and J11 FRAME PULSE; 1v/division.

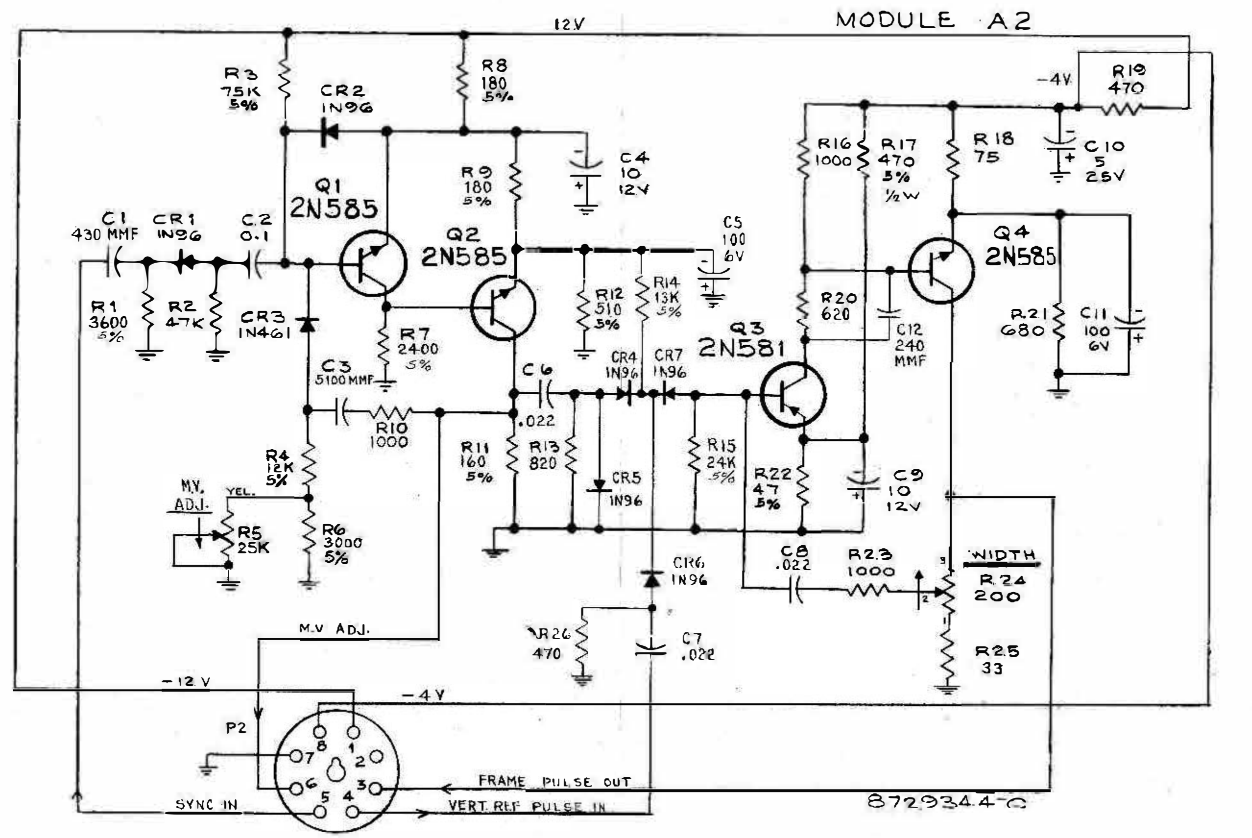
Figure RG-16. Waveforms for Point to Point Checking of Module A2 Including Related Chassis Components

LIST OF PARTS
REFERENCE GENERATOR 8974481-503

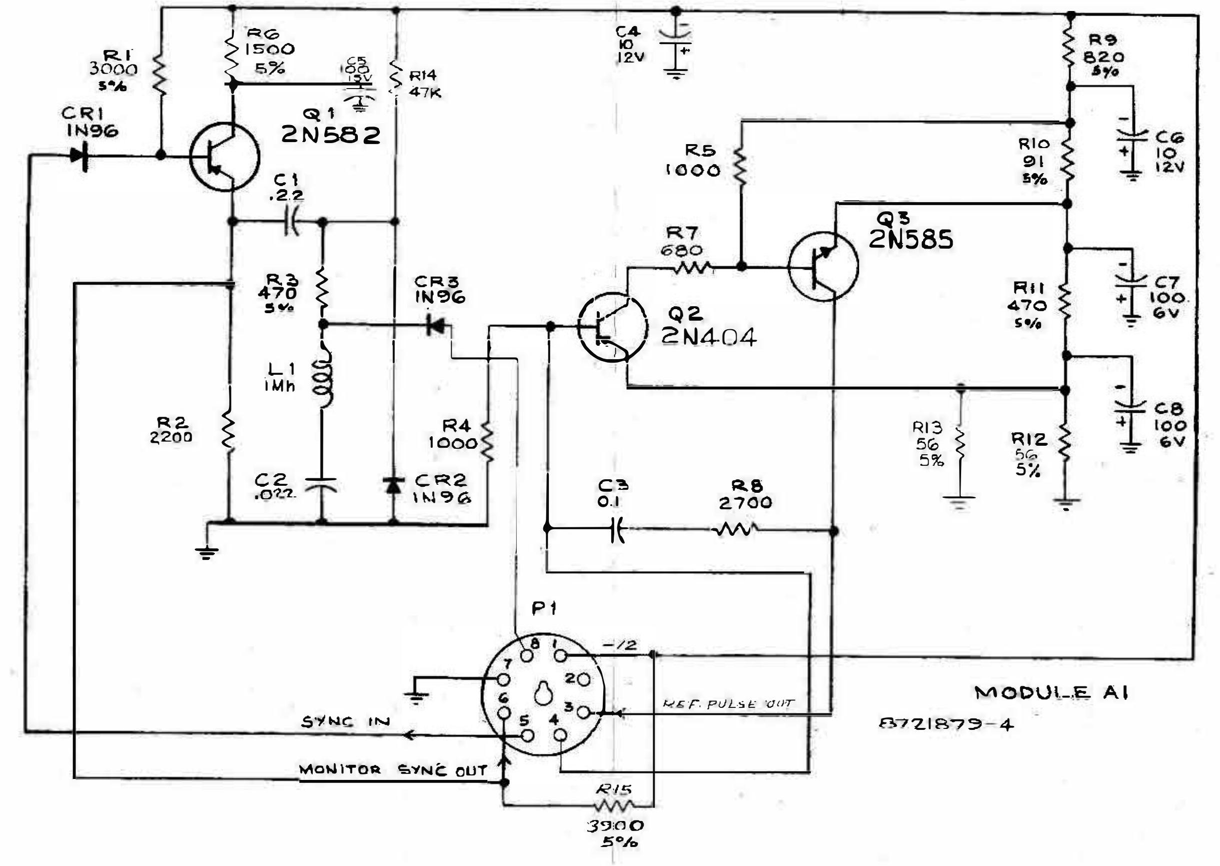
Symbol No.	Stock No.	Drawing No.	Description
CHASSIS ASSEMBLY 8974481-503			9
C1A,B/C2A,B	204056	458358-55	Capacitor: electrolytic, 200/200 μf 150 v
C3	212553	8959154-166	Capacitor: electrolytic, 50 μf 50 v
C4 to C7		8811182-5	Capacitor: ceramic, 10,000 $\mu\mu$f -20 +100%, 450 v
C8	219411	737818-492	Capacitor: paper, 0.068 μf ±10%, 100 v
C9	214465	8959154-415	Capacitor: electrolytic, 100 μf 15 v
C10	79784	8958264-10	Capacitor: electrolytic, 100 μf 12 v
CR1	219887		Diode: Reference, 1N1524A
CR2,CR3			Not Used
CR4,CR5,CR6	218612		Diode: type 1N2069
DS1,DS2	101857	872291-9	Lamp: indicator
F1	212327	990157-106	Fuse: 1/2 a 250 v
J1,J2	68590	99100-4	Connector: octal, 8 contacts
J3,J4			Not Used
J5	68590	99100-4	Connector: octal, 8 contacts
J6 to J12	51800	255223-2	Connector: coax
J13	51604	727969-3	Connector: male, 6 contacts
K1,K2	218223	460355-6	Relay: 24 v D.C. 3 P.D.T.
P1 to P5			Not Used
P6 to P8	66344	252868-1	Connector: coax, cable mtg.
P9	210715	8909771-501	Connector: male, coax termination
P10,P11			Connector: coax, cable mtg.
	66344	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P12	66344	252868-1	Connector: coax, cable mtg.
P13	51607	727969-4	Connector: female, 6 contacts
Q1	223366		Transistor: 2N404
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		82283-67	2700 ohms, ±10%, ½ w
R2			Pt. of XDS1
R3		82283-87	120,000 ohms, ±10%, ½ w
R4,R5			Not Used
R6,R7	206041	8909085-12	wire wound, 250 ohms, ±10%, 5 w
R8		82283-54	220 ohms, ±10%, ½ w
R9		82283-83	56,000 ohms, ±10%, ½ w
R10			Pt. of XDS2
R11		82283-59	560 ohms, ±10%, ½ w
R12		82283-54	220 ohms, ±10%, ½ w
R13,R14		82283-161	1200 ohms, ±5%, ½ w
R15		82283-135	100 ohms, ±5%, ½ w
T1	218621	8441371-1	Transformer: filament
XADS1,XASD2	208080	990788-507	Jewel: indicator light
XDS1,XDS2	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XK1,XK2	9915	746008-8	Socket: relay
MODULE A1 ASSEMBLY 8979781-502			7
			Capacitors:
C1	205117	737818-335	paper, 0.22 μf ±10%, 100 v
C2	212983	737818-489	paper, 0.022 μf ±10%, 100 v
C3	209076	737818-493	paper, 0.1 μf ±10%, 100 v
C4	218615	8959154-174	electrolytic, 10 μf 12 v
C5	214465	8959154-415	electrolytic, 100 μf 15 v
C6	218615	8959154-174	electrolytic, 10 μf 12 v
C7,C8	218614	8959154-129	electrolytic, 100 μf 6 v
CR1 to CR3	208380A		Diode: type 1N96

Symbol No.	Stock No.	Drawing No.	Description
L1	218608	8950364-501	Coil: 1 microhenry
P1	218620	8978057-1	Connector: male, 8 contacts
Q1	223371		Transistor: 2N582
Q2	223366		Transistor: 2N404
Q3	223370		Transistor: 2N585
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		722300-170	3000 ohm ±5%, ¼ w
R2		722300-66	2200 ohms, ±10%, ¼ w
R3		722300-151	470 ohms, ±5%, ¼ w
R4, R5		722300-62	1000 ohms, ±10%, ¼ w
R6		722300-163	1500 ohms, ±5%, ¼ w
R7		722300-60	680 ohms, ±10%, ¼ w
R8		722300-67	2700 ohms, ±10%, ¼ w
R9		722300-157	820 ohms, ±5%, ¼ w
R10		722300-134	91 ohms, ±5%, ¼ w
R11		722300-151	470 ohms, ±5%, ¼ w
R12, R13		722300-129	56 ohms, ±5%, ¼ w
R14		722300-82	47,000 ohms, ±10%, ¼ w
R15		722300-173	3900 ohms, ±5%, ¼ w
XQ1 to XQ3	218618	8707294-5	Socket: transistor
		MODULE A2 ASSEMBLY 8979751-502	9
			CAPACITORS:
C1		8914319-339	mica, 430 $\mu\mu$f ±5%, 300 v
C2	205579	737818-333	paper, 0.1 μf ±10%, 100 v
C3		8924416-326	mica, 5100 $\mu\mu$f ±5%, 300 v char "F"
C4	218615	8959154-174	electrolytic, 10 μf 12 v
C5	218614	8959154-129	electrolytic, 100 μf 6 v
C6 to C8	212983	737818-489	paper, 0.022 μf ±10%, 100 v
C9	218615	8959154-174	electrolytic, 10 μf 12 v
C10	218513	8959154-105	electrolytic, 5 μf 25 v
C11	218614	8959154-129	electrolytic, 100 μf 6 v
C12		8914319-333	mica, 240 $\mu\mu$f ±5%, 500 v char "F"
CR1, CR2	208380A		Diode: type 1N96
CR3	215669		Diode: type 1N461
CR4 to CR7	208380A		Diode: type 1N96
P2	218620	8978057-1	Connector: male, 8 contacts
Q1, Q2	223370		Transistor: 2N585
Q3	223372		Transistor: 2N581
Q4	223370		Transistor: 2N585
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		722300-172	3600 ohms, ±5%, ¼ w
R2		722300-82	47,000 ohms, ±10%, ¼ w
R3		722300-204	75,000 ohms, ±5%, ¼ w
R4		722300-185	12,000 ohms, ±5%, ¼ w
R5	218617	8980004-102	variable, comp., 25,000 ohms, 0.2 w
R6		722300-170	3000 ohms, ±5%, ¼ w
R7		722300-168	2400 ohms, ±5%, ¼ w
R8, R9		722300-53	180 ohms, ±10%, ¼ w
R10		722300-62	1000 ohms, ±10%, ¼ w
R11		722300-140	160 ohms, ±5%, ¼ w
R12		722300-152	510 ohms, ±5%, ¼ w
R13		722300-61	820 ohms, ±10%, ¼ w
R14		722300-180	7500 ohms, ±5%, ¼ w
R15		722300-192	24,000 ohms, ±5%, ¼ w
R16		722300-62	1000 ohms, ±10%, ¼ w
R17		82283-151	470 ohms, ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R18		722300-132	75 ohms, ±5%, ¼ w
R19		722300-58	470 ohms, ±10%, ¼ w
R20		722300-154	620 ohms, ±5%, ¼ w
R21		722300-60	680 ohms, ±10%, ¼ w
R22		722300-127	47 ohms, ±5%, ¼ w
R23		722300-62	1000 ohms, ±10%, ¼ w
R24	218616	8980004-2	variable, wire wound, 200 ohms, 0.25 w
R25		722301-123	33 ohms, ±5%, ¼ w
R26		722300-58	470 ohms, ±10%, ¼ w
XQ1 to XQ4	218618	8707294-5	Socket: transistor
		TEST MODULE A5 ASSEMBLY 8441319-502	1
J1	219413	8820973-15	Connector: tube, socket, 8 contacts
P5	218620	8978057-1	Connector: male, 8 contacts
TP1 to TP3	208983	8825493-7	Jack: tip, yellow
TP4			Not Used
TP5	205120	8825493-5	Jack: tip, blue



ALL RESISTOR VALUES IN OHMS ¼W±10% AND ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE INDICATED.



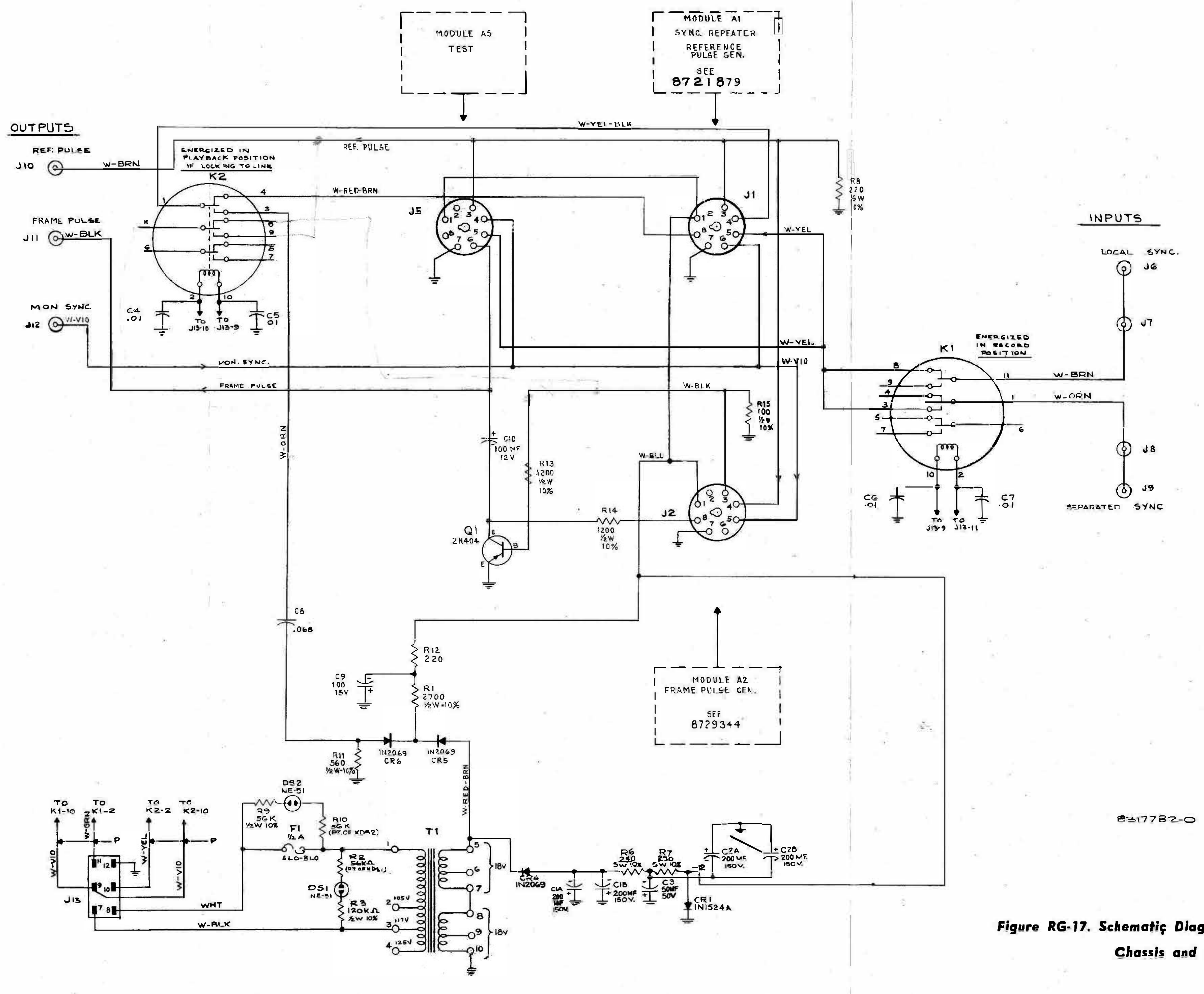


Figure RG-17. Schematic Diagrams for Reference Generator Chassis and Modules A1 and A2

ELECTRONIC RECORDING PRODUCTS

–150 Volt Power Supply

UNIT 405

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
BR 641

IB-31150

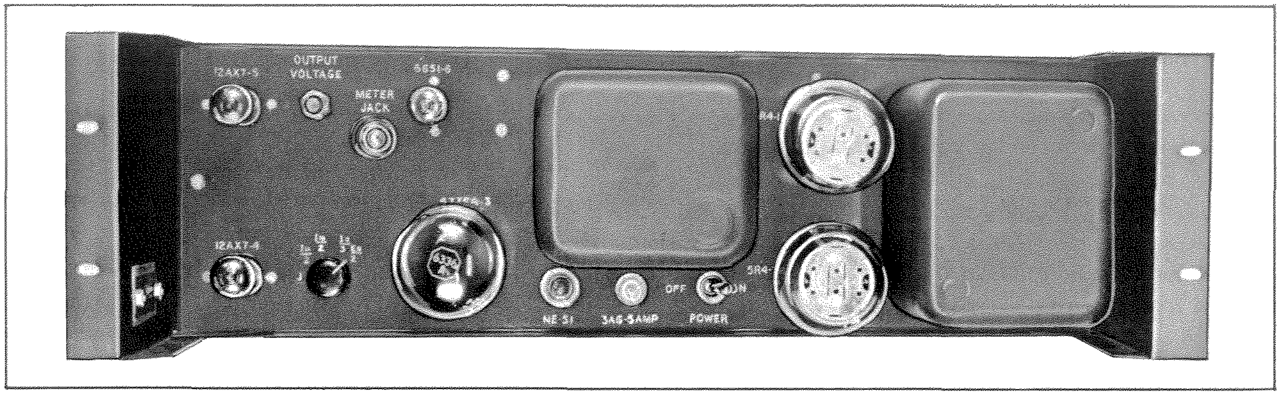


Figure NPS-1. —150 Volt Power Supply, Front View

TECHNICAL DATA

Power Required

117 volts, 50/60 cps, 910 watts
(from circuit breaker No. 4)

Power Supplied

Output voltage: —150 volts dc
(adjustable from —140 to —160 volts)
Output current: 400 ma (maximum)

Ripple Voltage

1.0 mv rms (maximum)

Regulation

a. 90 to 400 ma load: .05 volt dc maximum variation
b. 107 to 130 volts ac line variation: ±.15 volt dc maximum variation

Fuse

5 amperes, 3AG

Tube Complement

1 — 5651
1 — 6336A
2 — 5R4GY
2 — 12AX7

DESCRIPTION

The —150 volt regulated power supply (unit 405) is shown in Figure NPS-1. Its purpose is to provide approximately 230 milliamperes of current at —150 volts dc to the tone wheel amplifier (unit 505), guide servo (unit 506), and headwheel servo (unit 504). The output voltage of the unit is adjustable, and is essentially independent of load current or line voltage variations.

Controls

The controls on the front panel of the power supply consist of a POWER ON-OFF switch, OUTPUT VOLTAGE screwdriver adjustment, and metering switch (to permit selective metering of tube currents and output voltage and current).

Circuit

As shown on the schematic diagram, Figure NPS-3, the unit consists basically of a rectifier and voltage regulator circuit.

The input line voltage is applied to power transformer T1 through jack J1 (pins 6 and 7) in series with switch S1 and a 5 ampere fuse. (Lamp DS2, which is a part of the fuse holder assembly XF1, lights only when the fuse is open.) Transformer T1 is connected for 117 volts ac operation, but taps are provided for line voltages above or below 117 volts.

Two 5R4GY diodes (V1 and V2) provide full-wave rectification of the ac voltage applied by transformer T1. A choke input filter consisting of coil L1 and capacitors C1A and C2 smooths the rectified voltage before it is fed to the series regulating circuit.

The series regulating circuit includes a 6336A regulator tube (V3), a 5651 voltage reference tube (V6), and two 12AX7 voltage amplifier tubes (V4 and V5). Regulation is accomplished in the following manner:

Whenever an instantaneous change in output voltage occurs because of load or line voltage variations, a fraction of the voltage change appears at the grid of voltage amplifier V5A through the center-arm of potentiometer R25. The voltage change is then cathode coupled to V5B. Voltage reference tube V6, a miniature two-element gaseous tube of exceptional stability, maintains the grid of V5B at a constant

voltage level. The input and reference voltages are compared in V5B and the resultant difference voltage is fed to dc amplifiers V4B and V4A in turn. The cathodes of V4B and V4A are held at a relatively constant voltage level by voltage divider networks. Further amplification of the difference voltage is accomplished by V4, and the output voltage appearing at the plate of V4A is fed to both grids (pins 1 and 4) of V3 simultaneously. The control voltage applied to the grids of regulating tube V3 determines the grid-to-cathode voltage and hence the plate-to-cathode resistance of V3. The tube then functions as a variable resistance in series with the load, automatically adjusting itself to compensate for any changing load current or line voltage condition.

The NE-51 neon lamp, located on the front panel, is connected between the voltage divider R15, R16 and the grids of regulator tube V3 to protect the grids when the supply is first turned on. When the unit has reached operating condition, the neon lamp is extinguished.

When the unit is delivering −150 volts dc, relay K1 becomes energized. This connects pins 4 and 5 of jack J1, thus closing the circuit carrying 280 volts dc to the chassis supplied by the −150 volt power supply. Therefore, when the −150 volt power supply is not operating, no B+ voltage will be applied to the tonewheel amplifier, guide servo, or headwheel servo chassis.

Potentiometer R25 (OUTPUT VOLTAGE) is used to adjust the power supply output voltage between the approximate limits of −140 to −160 volts dc by varying the bias on V5A.

Wafer switch S2, used in conjunction with an MI-21200-C1 voltage and current indicating meter plugged into jack J3, provides a method of checking the plate currents flowing in each half of the regulator tube V3. This is accomplished by measuring the voltage drop across resistor R33 when S2 is in $I_{1A}/_2$ position, and by measuring the voltage drop across R34 when S2 is in $I_{1B}/_2$ position. The power supply output voltage and current may be checked in a similar manner by switching S2 to $E_o/_2$ and $I_o/_3$ positions respectively (see *Maintenance*).

MAINTENANCE

Voltage Adjustment

Adjust the power supply output voltage to −150 volts dc by means of the OUTPUT VOLTAGE screwdriver adjustment. The voltage may be measured by plugging an MI-21200-C1 meter into the METER JACK and rotating the metering switch to $E_o/_2$ position. Multiply the meter reading by two to obtain the actual voltage value. A vacuum-tube voltmeter may be used to make this measurement if an MI-21200-C1 meter is not available, by connecting the VTVM across a phono-plug inserted into the METER JACK and reading the voltage directly. *Care must be taken not to ground the VTVM case to the power supply chassis when making this measurement.*

Metering

To check the plate currents of the 6336A regulator tube, plug an MI-21200-C1 meter (or vacuum-tube voltmeter as noted above) into the METER JACK and rotate the metering switch to $I_{1A}/_2$ and $I_{1B}/_2$ positions. The two current readings obtained must be approximately equal to insure maximum efficiency and long life of the tube. Replace the regulator tube when the current unbalance exceeds 12 milliamperes. (For actual current values, multiply MI-21200-C1 meter reading by two.)

The output voltage and current may be checked in a similar manner by rotating the metering switch to $E_o/_2$ position for voltage, and to $I_o/_3$ position for current.

The currents and output voltage noted above may be checked while the power supply is in operation without affecting its performance. For typical current and voltage readings, see *Metering Chart.*

Ripple Voltage

Check the ripple voltage by measuring it with an oscilloscope, using a direct probe. A convenient place to make the measurement is at terminal board 4TB2, connections 6 and 7, located at the rear of rack 4. If the ripple voltage exceeds 1.5 millivolts, the 6336A regulator tube should be replaced.

METERING CHART

Metering Switch Position	*MI-21200-C1 Meter Reading*	*Vacuum-Tube Voltmeter Reading*	*Actual Value*
$E_o/_2$	75	150 volts	150 volts
$I_o/_3$	75	0.75 volt	225 ma
$I_{1A}/_2$	67	0.67 volt	134 ma
$I_{1B}/_2$	66	0.66 volt	132 ma

Trouble Shooting

Tube failure or deterioration is the most likely cause of faulty operation of the power supply; therefore, check all tubes as the first step in trouble-shooting the unit.

An open fuse will be indicated by the illumination of the NE-51 neon lamp located on the front panel below the coil housing. Always replace the fuse with the exact value required (5 amperes, 3AG). If the replacement fuse opens immediately, do not replace it until the cause of the trouble has been corrected.

Voltage Readings

The *Voltage Table* indicates typical tube socket voltages with respect to ground, obtained with a vacuum-tube voltmeter. All voltages are dc unless otherwise noted.

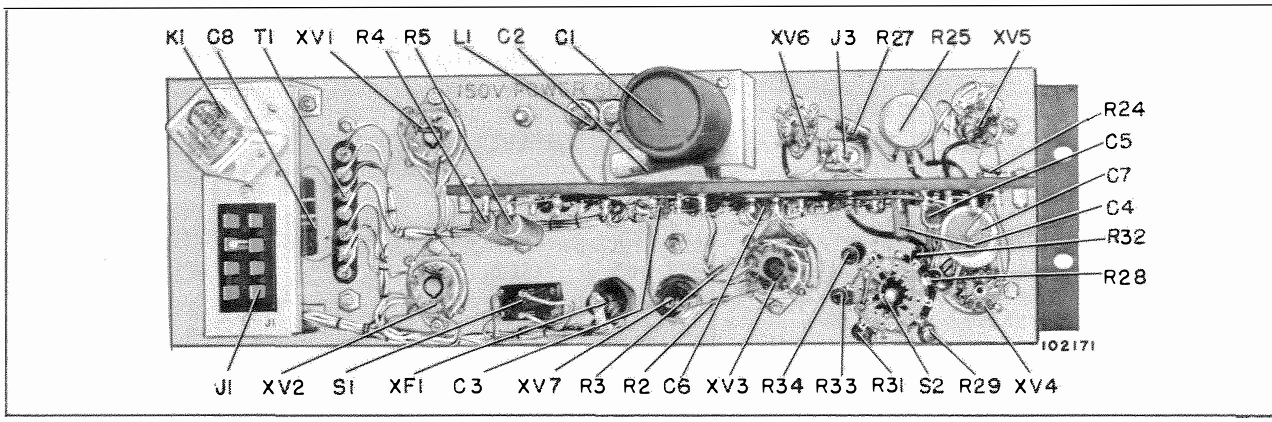


Figure NPS-2. Rear View of Power Supply

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			-150 VOLT POWER SUPPLY (8956034-502) 10
			CAPACITORS:
C1A, B	218121	458558-45	electrolytic, 40/40 μf +50 -10%, 475 v
C2		735715-175	paper, 0.1 μf ±10%, 400 v
C3		727856-137	mica, 390 $\mu\mu$f ±10%, 500 v char "B"
C4		727866 157	mica, 2700 $\mu\mu$f ±10%, 500 v char "B"
C5		735715-171	paper, 0.047 μf ±10%, 400 v
C6		735715-175	paper, 0.1 μf ±10%, 400 v
C7		735715-183	paper, 0.47 μf ±10%, 400 v
C8		735715-175	paper, 0.1 μf ±10%, 400 v
DS2			Lamp: part of XF1
F1	94802	990157-113	Fuse: 5 amp
J1	55806	727969-7	Connector: male, 8 contact, chassis mtg.
J2			Not Used
J3	18466	8909777-1	Jack
K1	215302	460355-5	Relay
L1	218122	949888-1	Reactor
P1	55808	727969-8	Connector: female, 8 contact, cable mtg.
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R1		99126-228	750,000 ohm ±5%, 2 w
R2, R3		82283-51	120 ohm ±5%, ½ w
R4, R5	47492	458574-22	wire wound, 100 ohm ±5%, 10 w
R6	218123	990185-537	film, 237,000 ohm ±1%, ½ w
R7	209781	990185-581	film, 681,000 ohm ±1%, ½ w
R8		99126-75	12,000 ohm ±10%, 2 w
R9		99126-186	13,000 ohm, ±5%, 2 w
R10		99126-63	1200 ohm ±10%, 2 w
R11		99126-75	12,000 ohm ±10%, 2 w
R12		99126-186	13,000 ohm ±5%, 2 w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R13		90496-216	240,000 ohm ±5%, 1 w
R14		99126-63	1200 ohm ±10%, 2 w
R15		90496-77	18,000 ohm ±10%, 1 w
R16		90496-84	68,000 ohm ±10%, 1 w
R17	218124	990185-593	film, 909,000 ohm ±1%, ½ w
R18	218123	990185-537	film, 237,000 ohm ±1%, ½ w
R19		90496-86	100,000 ohm ±10%, 1 w
R20		82283-51	120 ohm ±10%, ½ w
R21		99126-86	100,000 ohm ±10%, 2 w
R22		82283-79	27,000 ohm ±10%, ½ w
R23		90496-86	100,000 ohm ±10%, 1 w
R24		82283-51	120 ohm ±10%, ½ w
R25	218125	433196-18	variable, comp., 5000 ohm, 2 w
R26		99126-76	15,000 ohm ±10%, 2 w
R27		99126-78	22,000 ohm ±10%, 2 w
R28	211415	258656-34	film, 5 ohm ±1%, 1 w
R29	215410	258656-7	film, 10 ohm ±1%, 1 w
R30			Not Used
R31	211416	258656-35	film, 60 ohm ±1%, 1 w
R32	56085A	258656-27	film, 200,000 ohm ±1%, 1 w
R33,R34	211415	258656-34	film, 5 ohm ±1%, 1 w
R35		82283-90	220,000 ohm ±10%, ½ w
R36		90496-190	20,000 ohm ±5%, 1 w
S1	93263	95559-5	Switch: toggle
S2			Not Used
S3	219952	8442531-1	Switch: rotary, 4 position
T1	218126	949889-1	Transformer: power
V3	211419A		Tube: type 6336A
V7	101857	872291-9	Lamp: neon NE51
XF1	211618	8920191-2	Holder: fuse
XK1	68590	99100-4	Socket: relay
XV1 to XV3	68590	99100-4	Socket: tube, 8 pin
XV4,XV5	94926	737870-14	Socket: tube, 9 pin
XV6	94925	737867-14	Socket: tube, 7 pin
XV7		8876203-7	Socket: neon lamp
	56100		Socket only
	208080		Jewel only
			Miscellaneous:
	205329	741622-501	Knob

Symbol No.	Stock No.	Drawing No.	Description
C80		727876-163	mica, 4700 $\mu\mu$f ±10%, 500 v char "B"
C81	219661	8924416-119	mica, 2700 $\mu\mu$f ±1%, 500 v
C82		735715-175	paper, 0.1 μf ±10%, 400 v
C83, C84	209079	737816-95	paper, 0.22 μf ±10%, 400 v
C85A/B	32342	95695-37	electrolytic, 10/10 μf 450 v
C86		727876-167	mica, 6800 $\mu\mu$f ±10%, 500 v char "B"
C87		735715-175	paper, 0.1 μf ±10%, 400 v
C88	211169	737863-37	paper, 1 μf ±10%, 100 v
C89 to C91		8811182-5	ceramic, 10,000 $\mu\mu$f -20 +100%, 450 v
C92, C93			Not Used
C94	211545	471574-32	electrolytic, 5 μf 450 v
C95	95624	737818-96	paper, 0.47 μf ±10%, 400 v
C96	211741	737818-17	paper, 1 μf ±10%, 100 v
CR1 to CR9	99483		Diode: type 1N54A
CR10 to CR15	108915		Diode: type 1N2069
DS1, DS2	101857	872291-9	Lamp: indicator
F1	218628	990157-107	Fuse: 3/4 A 250 v
FL1	218623	8976975-1	Filter: electrical, 240 cycle
J1	51800	255223-2	Connector: coax, chassis mtg.
J2	56077	727969-5	Connector: female, 8 contacts
J3, J4	51800	255223-2	Connector: coax, chassis mtg.
J5	51594	727969-1	Connector: female, 6 contact
J6, J7	51800	255223-2	Connector: coax, chassis mtg.
J8	53140	727969-15	Connector: female, 12 contacts
J9	51604	727969-3	Connector: male, 6 contact
J10, J11	51800	255223-2	Connector: coax, chassis mtg.
K1, K2	218223	460355-6	Relay: 3 P.D.T.
K3	206744	460355-2	Relay: D.P.D.T.
K4			Not Used
K5	218223	460355-6	Relay: 3 P.D.T.
L1	218622	8973724-1	Coil: 1.25 H 26 MA
L2			Not Used
L3	211803	8980021-1	Coil: 15/60 millihenry
P1			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P2	58978	727969-6	Connector: male, 8 contact
P3, P4	215661	252868-1	Connector: coax, cable mtg.
P5	51595	727969-2	Connector: male, 6 contacts
P6	215661	252868-1	Connector: coax, cable mtg.
P7			Connector: coax, cable mtg.
	215661	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P8	54253	727969-16	Connector: male, 12 contacts
P9	51607	727969-4	Connector: female, 6 contacts
P10	215661	252868-1	Connector: coax, cable mtg.
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1		82283-111	10 ohms, ±5%, ½ w
R2		82283-78	22,000 ohms ±10%, ½ w
R3		82283-65	1800 ohms, ±10%, ½ w
R4		82283-86	100,000 ohms, ±10%, ½ w
R5		82283-98	1 meg ±10%, ½ w
R6		82283-65	1800 ohms, ±10%, ½ w
R7		82283-74	10,000 ohms, ±10%, ½ w
R8		82283-98	1 meg ±10%, ½ w
R9		82283-90	220,000 ohms, ±10%, ½ w
R10		82283-71	5600 ohms, ±10%, ½ w
R11		82283-98	1 meg ±10%, ½ w
R12		82283-90	220,000 ohms, ±10%, ½ w
R13		82283-65	1800 ohms, ±10%, ½ w
R14, R15		82283-215	220,000 ohms, ±5%, ½ w
R16		82283-208	110,000 ohms, ±5%, ½ w

280 Volt Power Supply*

UNITS 409, 410

* 60 cycle version similar to Type WP-16B, MI-26089-B
50 cycle version similar to Type WP-16B, MI-26094-B

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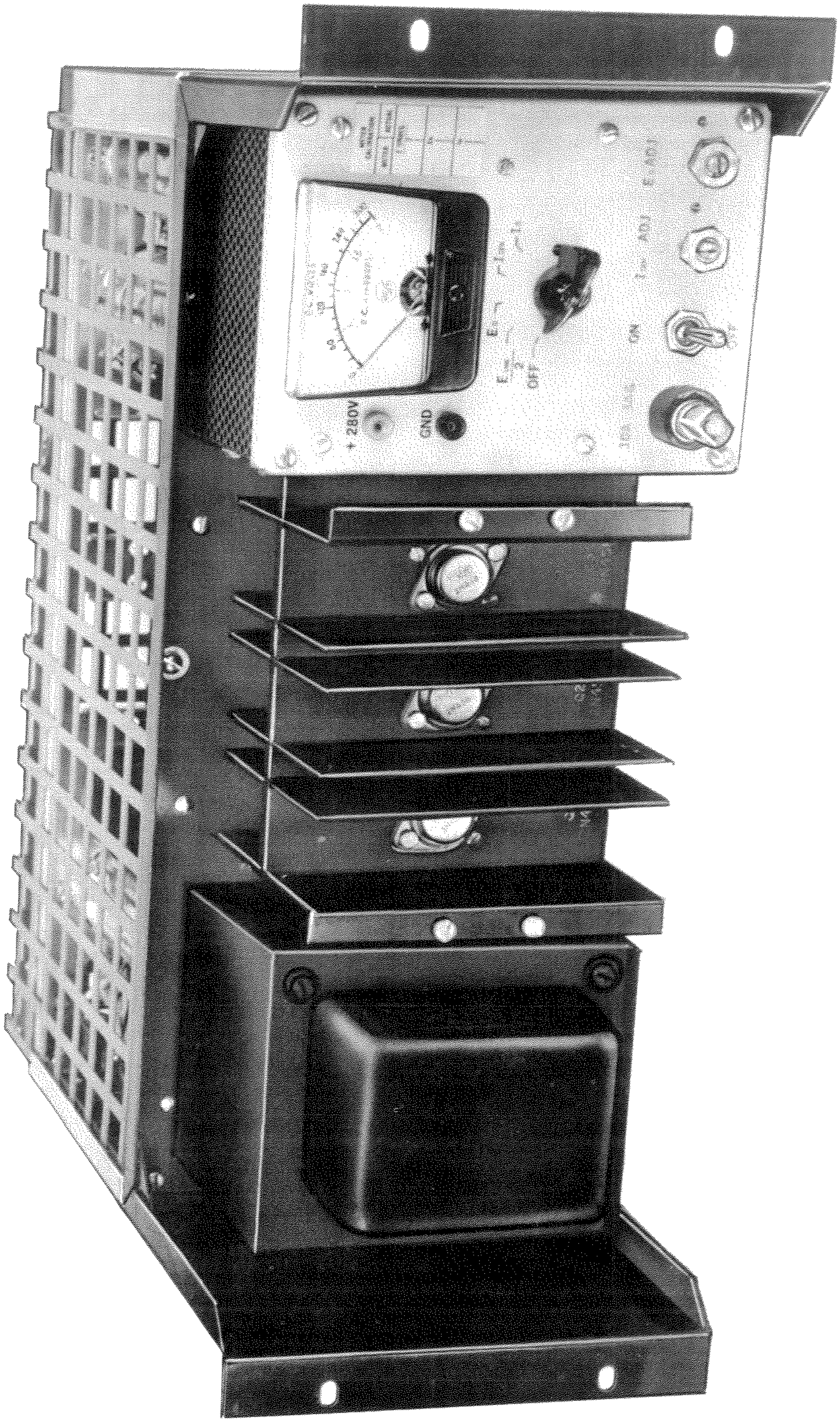


Figure PPS-1. 280 Volt Power Supply

TECHNICAL DATA

Input Voltage
95 to 130 volts ac

Input Frequency
60 Cycle Unit: 60 ±1 cycle per second
50 Cycle Unit: 50 ±1 cycle per second

Input Power
500 to 600 watts

Efficiency
Full Load: (1600 ma) 65%
2/3 Load: (1000 ma) 55%
1/3 Load: (500 ma) 45%

Maximum Rate of Line Current Change
2 x 10^3 amp/sec.

Regulated Output Voltage
275 to 290 volts, adjustable

Output Current
0.0 to 1.6 amperes

Capacitance Loading
Infinite

Stabilization
0.05 volt output change for ±18 volts line change

Long Term Stability
Not over 1.0 volt variation with constant load and temperature

Ripple and Noise
Less than 2.5 millivolts peak-to-peak

Regulation
Less than 0.1 volt change, 0.0 to 1.6 amperes

Output Impedance
0.10 ohm to 2 KC; 0.15 ohm to 50 KC

Short Circuit Load Performance
Self protecting; normal operation resumed when short is removed

Time Delay
45 seconds (nominal)

Semiconductor Complement

Transistors:	1	2N333
	2	2N1040
	4	2N458
	1	2N1012
Diodes:	3	1N429
	1	651C4
Rectifier:	1	4JA211CB2AC1

DESCRIPTION

The 280 Volt Power Supply (figure PPS-1) is an all semiconductor power supply which is capable of supplying current loads from 0 to 1600 milliamperes at a nominal output of +280 volts. The RCA Television Tape Recorder uses two of these power supplies to provide the B+ voltages for all units having no self-contained power supplies. The power supply is contained in a 7-inch bath tube chassis and is rack mounted for easy accessibility.

The front control panel of the power supply consists of an ON-OFF switch, a meter, meter selector switch, 280 volt test jack, and a fuse receptacle. There are two output adjustments, I_{cen} ADJ and E_o ADJ. The E_o ADJ which adjusts the regulated output voltage is the only adjustment used on the front panel. The nominal regulated voltage range is 275 to 290 volts. The I Centering and E Unregulated chassis are not used as a part of the power supply with the tape system; therefore, the I_{cen} ADJ pot, and the I_{cen} and E_{unr} positions of the selector switch may be disregarded.

The unit has three series regulator transistors that are mounted on a heat sink which is on the front of the chassis. These three regulator transistors can be removed from the front of the unit.

Mounted to the rear of the meter panel (see figure PPS-8) is a circuit board which contains a dc amplifier for the 280 volt regulated supply. Mounted directly to the rear of the circuit board is the regulator driving transistor. The main power transformer, which has considerable weight, is mounted on the left-frame of the main chassis where it can easily be seen and its weight taken into account if the unit ever requires dismounting.

Circuit

The ac power is first applied to the ON-OFF switch, and then to the time delay circuit which closes the fused primary circuit of the main power transformer after a nominal 45 second delay. The secondary of the power transformer supplies ac power to the regulator voltage supply (see schematic diagram figure PPS-9).

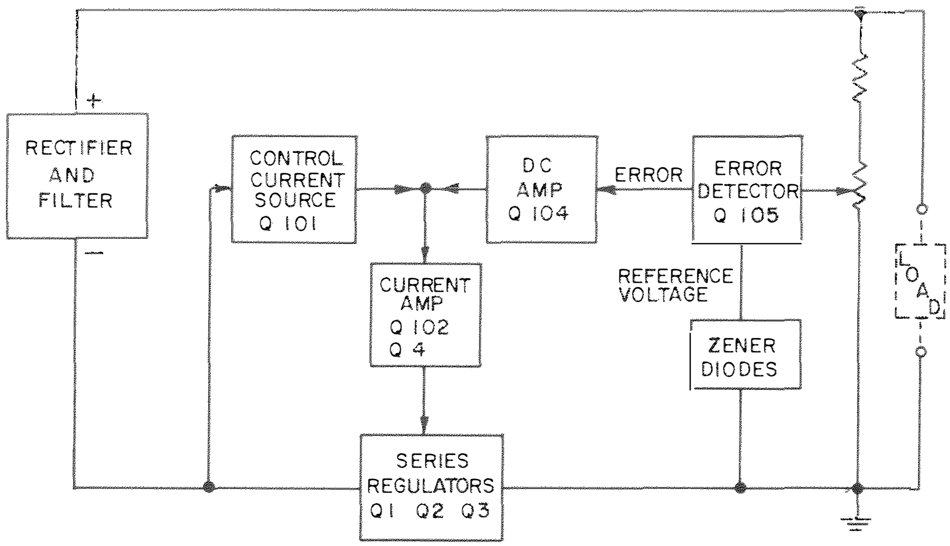


Figure PPS-2. Block Diagram, 280 Volt Power Supply

Time Delay Circuit

The time delay circuit in the 280 volt supply prevents application of plate voltage until the filaments of the powered units reach operating temperature. In the event of a momentary power failure, the relay does not recycle; however, it will recycle and reintroduce the time delay for power failures of more than several seconds.

When the ON-OFF switch S1 is closed, the thermal time-delay relay, K1, is energized. Following a 45 second delay period the relay contacts close and apply power to a rectifier-filter combination which consists of CR2, R11, and C8. The output of this circuit is applied to the coil of the main power relay, K2, causing its contacts to close and apply ac to the primary of the power transformer T1.

Regulated Supply

The output of the voltage regulated secondary of T1 (as shown in schematic diagram figure PPS-9) is applied to a bridge rectifier, CR1. The rectified output is then filtered by a capacity input filter. The filtered output is then applied to the regulator circuit, which operates as follows:

Series regulation is used with the parallel connected series regulator transistors, Q1, Q2, and Q3, in the ground side of the supply (see block diagram figure PPS-2). These regulator transistors are controlled by a transistor dc amplifier which senses variations of the output voltage as a result of either load changes or input voltage changes. This change, which represents an error, is sensed by the base of the first dc amplifier Q105. A reference voltage is applied to the emitter of Q105 by the series Zener diodes CR102, CR103 and CR104; since the Zener diodes have a constant voltage across them, this voltage is used as a reference. In Q105 the error is amplified, and inverted, and applied to the base of a second amplifier Q104. Here again inversion takes place.

The collector load of Q104 consists of transistor Q101 and the base circuit of Q102. Since the base voltage of Q101 is held constant by Zener diode CR101, it acts as a constant current supply for transistor Q104. Thus any change in the Q104 collector current due to the applied error signal will be applied to the base of the third amplifier Q102 resulting in a very high gain.

The Q101 emitter resistance is made variable by the D.C. Amplifier Control, R118, to permit adjustment to optimum power supply operating conditions. This is a factory adjustment and need not be made again under normal conditions. Refer to the *Maintenance* section of this instruction book for use of this control.

Q102 is an emitter follower (current gain) amplifier whose output drives emitter follower transistor Q4, which in turn drives series-regulator transistors Q1, Q2, and Q3 (connected in parallel with each other). The amplified error is applied to the series regulators in such a way as to oppose the error and keep the output nearly constant.

Capacitor C13, in the collector circuit of Q105, improves the high frequency coupling to the base of the input stage which results in a decrease of

ripple and high frequency output impedance characteristics. Capacitor C102 and C106 are decoupling capacitors which minimize the possibility of spurious high frequency oscillations.

Short Circuit Protection

The power transformer, T1, used with this power supply is a special regulating type with the property that the amount of power it can deliver under heavy loads is very low. The short circuit current is approximately 1 ampere, which is less than the rated full load current. Therefore the power supply transistors will be operating within their ratings under short circuit conditions. However, it takes a short time for this power reduction to occur, and the surge current could damage the transistors. Protection during this time is obtained as follows:

At the first instant of a short circuit, the surge current that flows through the limiting resistor R19, develops enough voltage to prevent breakdown of the regulators Q1, Q2, Q3, the regulator driver Q4, the dc amplifier transistor Q101, and the Zener diode CR101. The drop to zero-output-voltage is sensed by the input dc amplifier which in a few milliseconds drives the regulators into saturation. The resistance of the regulators then drops to a very low value thereby limiting the regulator collector dissipation to a safe value during the remainder of the surge. The steady state short-circuit-current is approximately 1 ampere.

OPERATION

The operation of the 280 volt power supply is relatively simple. Once the unit is turned on and the proper adjustments are made, there is no further need for close attention. The following procedure is all that must be done:

Place the ON-OFF switch to ON position. Wait for the time delay relay to close; then place the selector switch in the E_o position, and adjust the E_o ADJ control on the front panel for 280 volts on meter M1. Use an external meter of known calibration when precise voltage readings are desired.

MAINTENANCE

Transistors

Under normal conditions, no adjustments are necessary when transistors are replaced. However, if desired, optimum ripple and impedance performance can be obtained by readjustment of the D.C. AMPL ADJ control R118 (see figure PPS-8, and schematic diagram figure PPS-9). To determine whether this adjustment is necessary, proceed as follows:

1. Provide an external dc load of 1.5 amperes for a setting of 290 volts of regulated voltage.

2. Observe ripple (on an oscilloscope). If 2 millivolts peak-to-peak or less appear, no further adjustment is necessary. If ripple is greater than 2 millivolts peak-to-peak, proceed to step 3.

3. Adjust the D.C. AMPL ADJ control (R118) for minimum ripple.

4. Adjust the E_0 ADJ (on front panel) for a meter reading of 280 volts and resume normal operation.

Fuse Replacement

If a fuse needs replacement, never replace it with one of a higher rating. If the replacement fuse blows immediately, do not replace it until the cause of the trouble has been corrected.

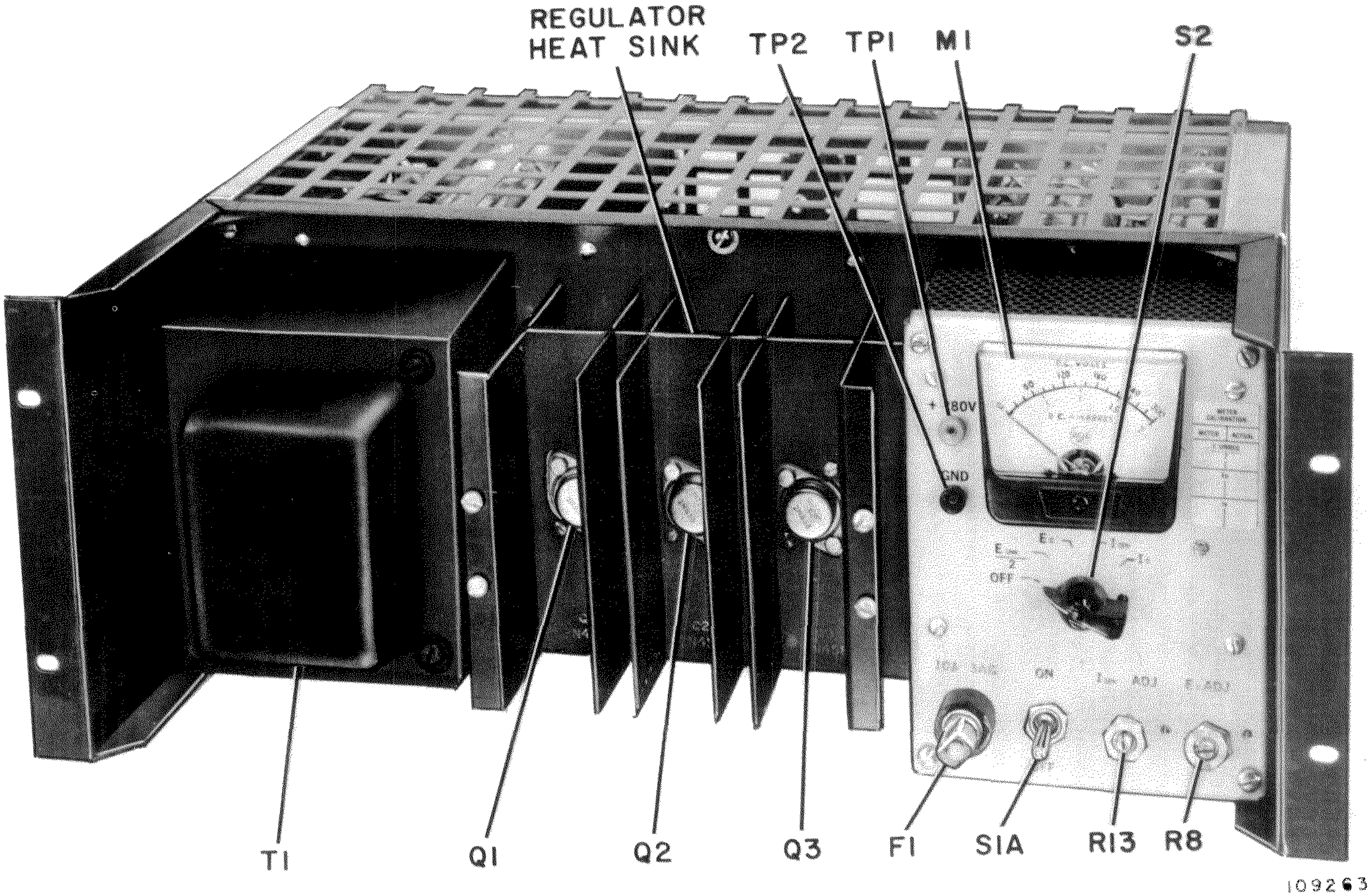


Figure PPS-3. Front View Showing Components and Panel Controls

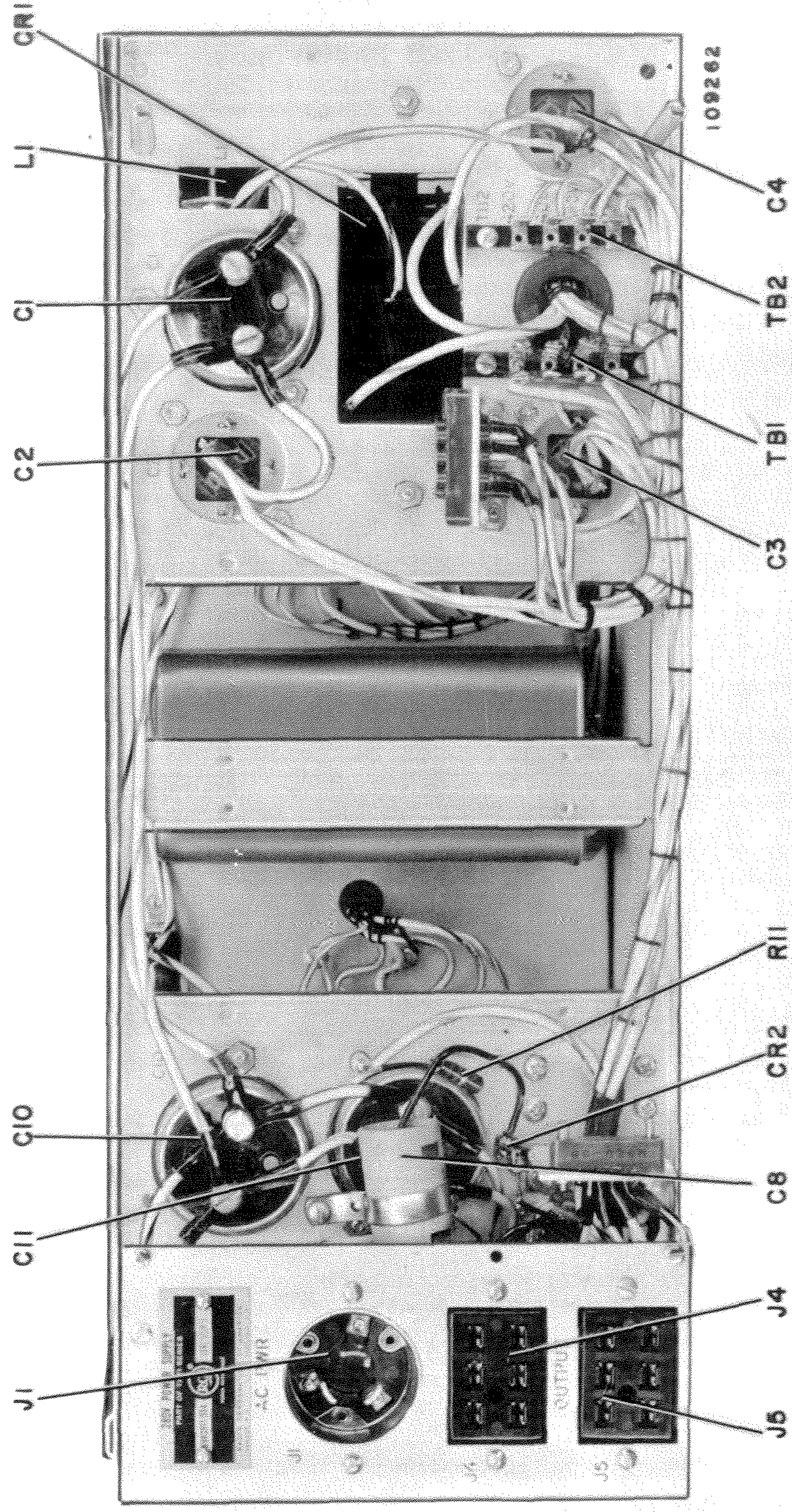


Figure PPS-4. Component Identification, Rear View

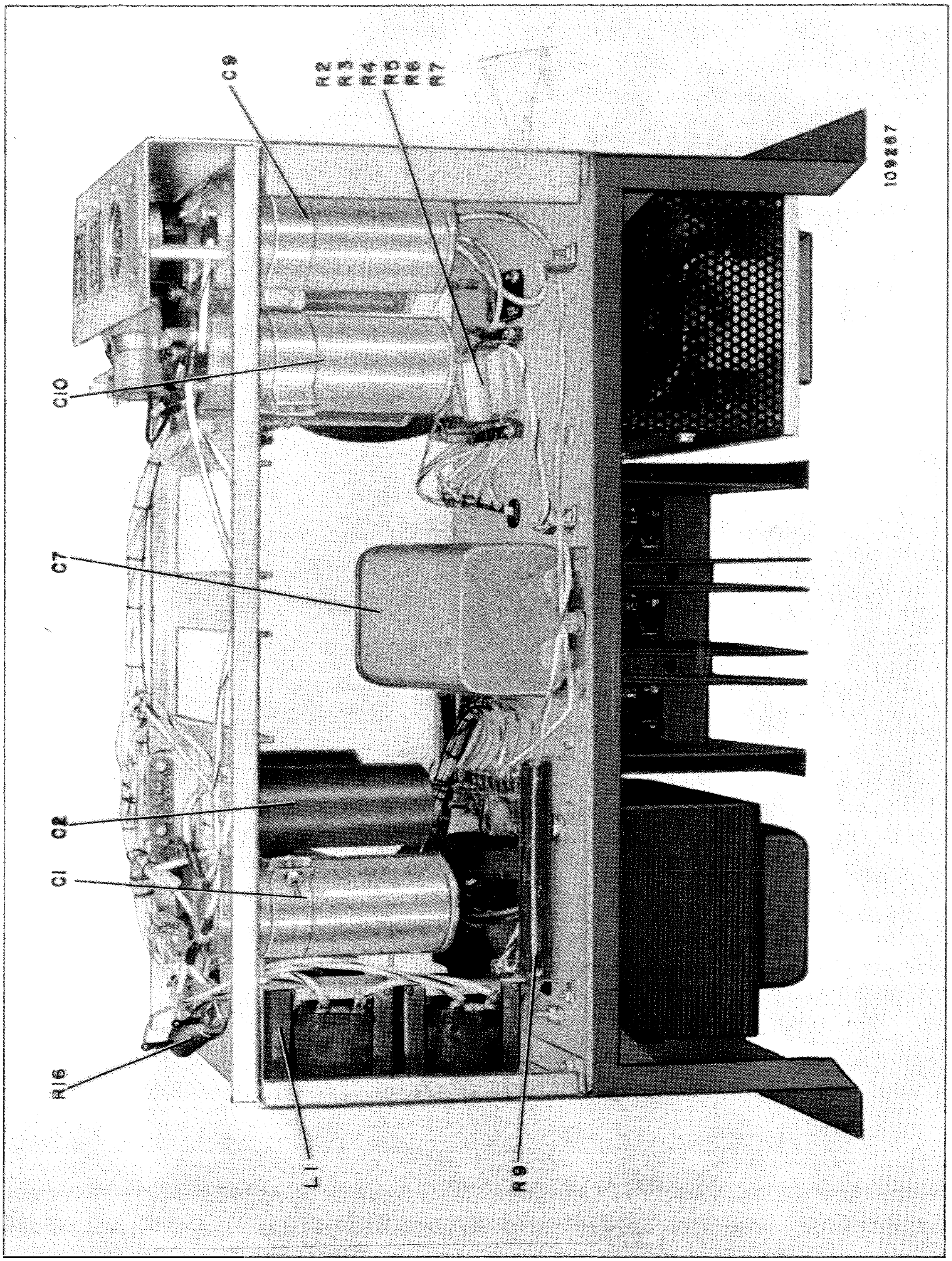


Figure PPS-5. Component Identification, Top View

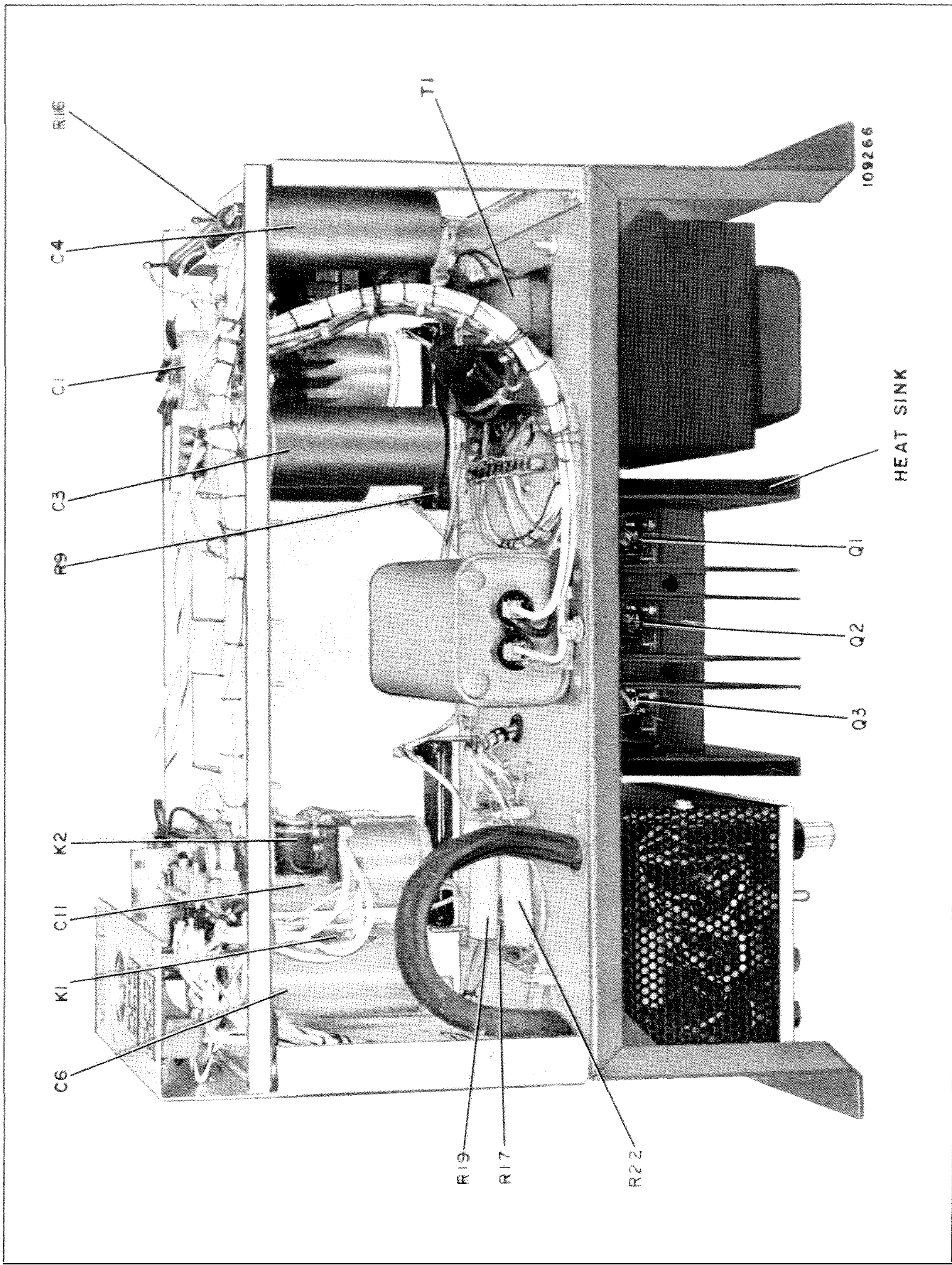


Figure PPS-6. Component Identification, Bottom View

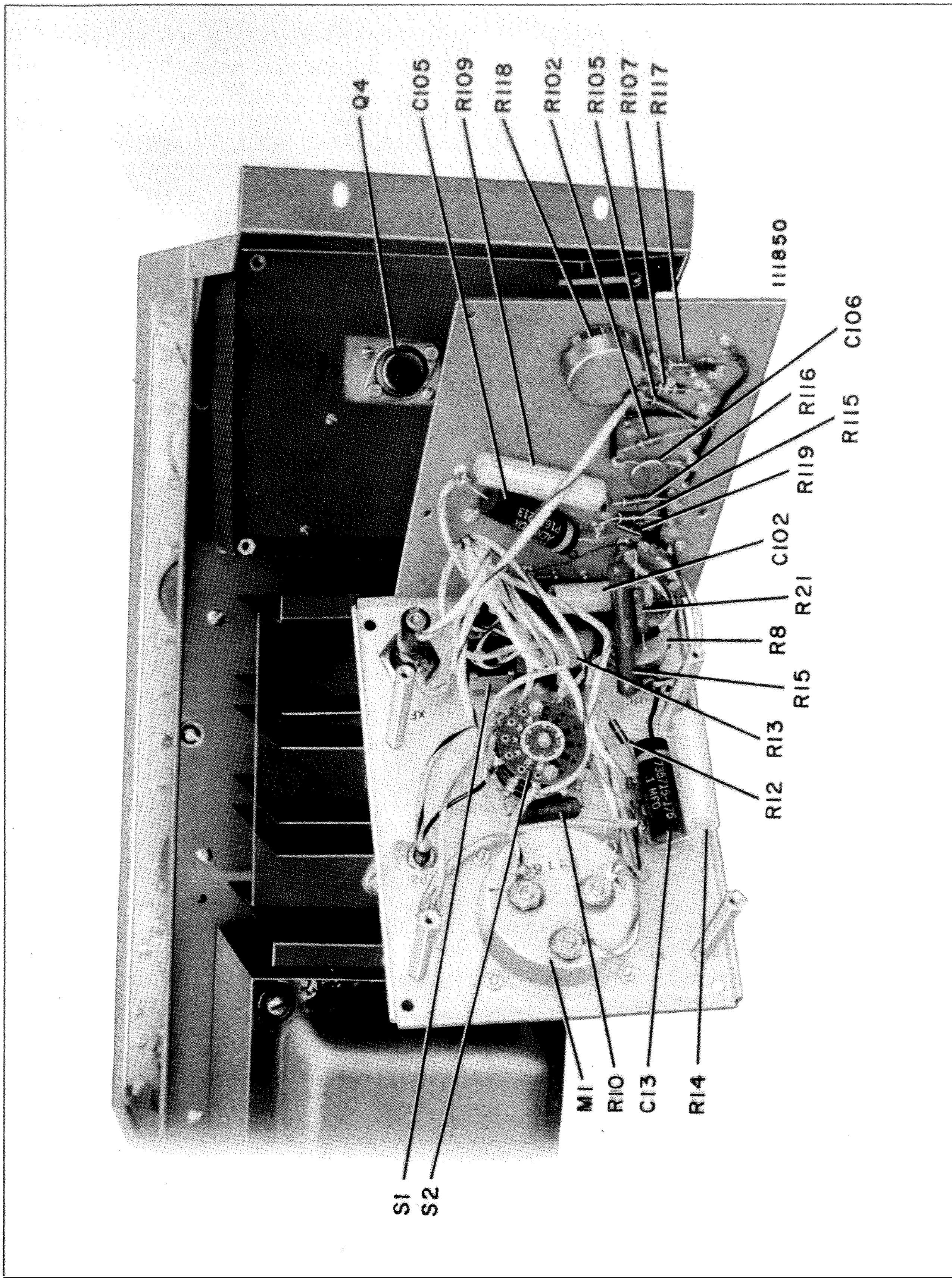


Figure PPS-7. Exposed View of Component Assembly Board and Front Panel

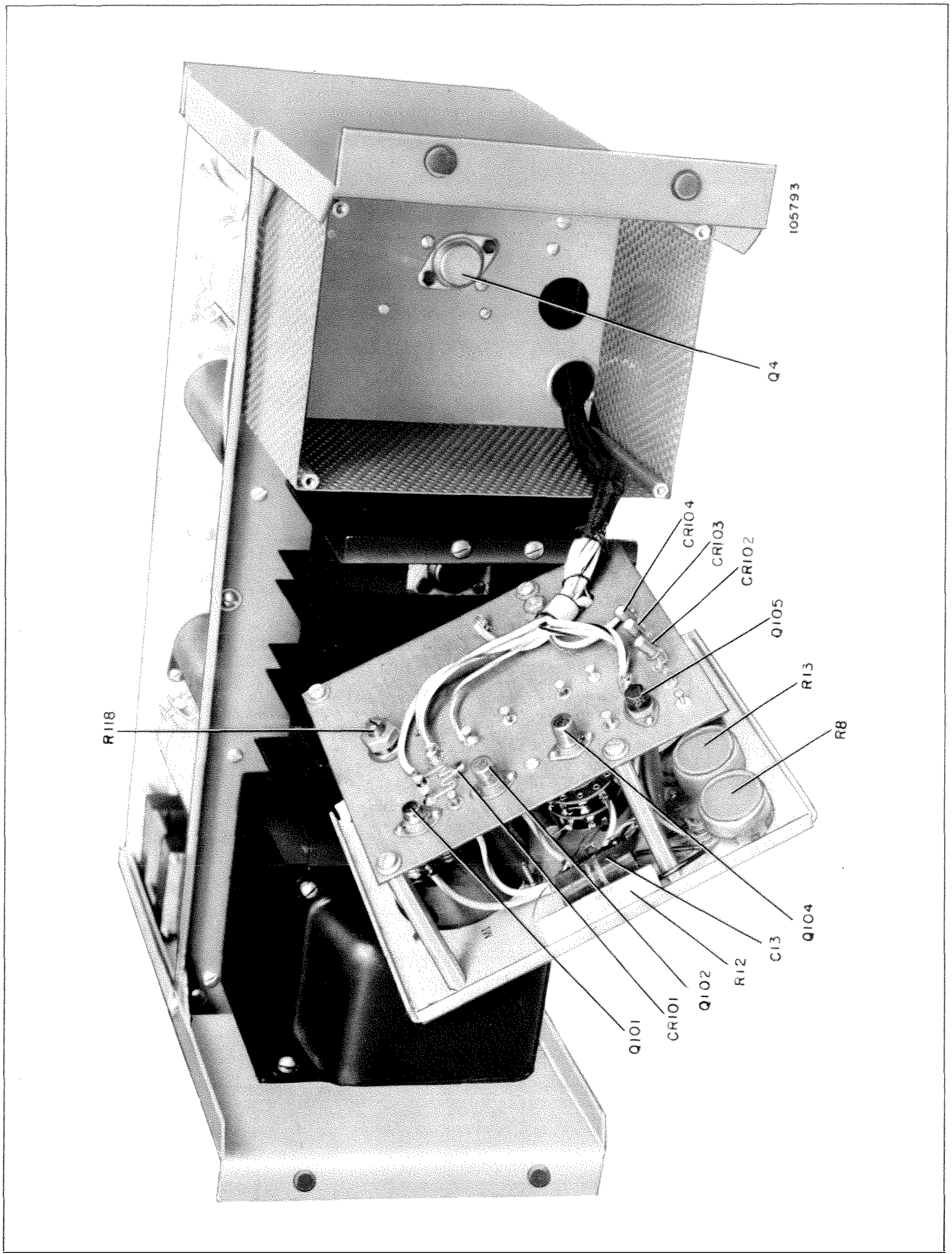


Figure PPS-8. Rear View of Component Assembly Board, Front Panel Removed from Main Chassis

LIST OF PARTS

Symbol No.	Stock No.	Drawing No.	Description
			POWER SUPPLY (TRANSISTORIZED) (8983911-504), 60 CYCLE — (#8983911-505), 50 CYCLE
			CAPACITORS:
C1	221618	8975570-16	electrolytic, 300 μf 350 v
C2 to C4	95914	458558-1	electrolytic, 125 μf 350 v
C5	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C6	221618	8975570-16	electrolytic, 300 μf 350 v
C7		8728432-3	25 μf, pt. of T1
C8	96216	442901-174	electroltyic, 10 μf 450 v
C9 to C11	221618	8975570-16	electrolytic, 300 μf 350 v
C12	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C13		735715-175	paper, 0.1 μf ±10%, 400 v
CR1	210347	8974309-1	Rectifier: silicon
CR2	218392		Diode: type 1N540
DS1			Part of XF1
F1	94709	8845660-6	Fuse: 10 amp
J1		8980085-1	Connector: male, A.C.
J2	207356	474619-2	Connector: female, 7 contacts
J3	209765	475145-2	Connector: female, 9 contacts
J4,J5	51594	727969-1	Connector: female, 6 contacts
K1	221610	8989717-1	Relay: time delay
K2	221612	8448880-1	Relay: 110 v
L1,L2	221615	8449588-1	Relay: filter
M1	221614	8462494-1	Meter: 0-300 v D.C.
P1		8980084-1	Connector: female, A.C.
P2,P3			Not Used
P4,P5	51595	727969-2	Connector: male, 6 contacts
Q1 to Q4	221605		Transistor: 2N458
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1			Part of XF1
R2 to R4	221611	993007-29	wire wound, 2.5 ohms, ±10%, 5 w
R5 to R7	210854	993007-21	wire wound, 1.0 ohms, ±10%, 5 w
R8	98221	8971860-105	variable, 500 ohms, ±10%, 2 w
R9	46071	427230-21	wire wound, 4000 ohms, ±10%, 50 w
R10	212130	990187-547	301,000 ohms, ±1%, 1 w
R11		90496-71	5600 ohms, ±10%, 1 w
R12		82283-53	180 ohms, ±10%, ½ w
R13	56596	8971860-108	variable, 2500 ohms, ±10%, 2 w
R14	219511	993008-107	wire wound, 20,000 ohms, ±5%, 10 w
R15	221604	990190-309	1210 ohms, ±1%, 2 w
R16	46071	427230-21	wire wound, 4000 ohms, ±10%, 50 w
R17,R18		727834-570	6.2 ohms, ±5%, ½ w
R19		993008-29	wire wound, 2.5 ohms, ±5%, 10 w
R20	98600	458572-64	4000 ohms, ±5%, 5 w
R21	223129	990186-389	film, 8250 ohms, ±1%, ½ w
R22		993008-29	wire wound, 2.5 ohms, ±5%, 10 w
S1	204583	990780-109	Switch: D.P.D.T.
S2	221613	8449586-1	Switch: rotary, 3 sec. 3 pos.
T1	221616	8728432-1	Transformer: power, *60 cycle*
T1	221617	8728432-2	Transformer: power, *50 cycle*
TP1	203532	8825493-2	Connector: tip jack, red
TP2	205675	8825493-3	Connector: tip jack, black
XF1	211618	8920191-2	Holder: fuse, less resistor
XK1	94926	737870-14	Socket: relay
XQ1 to XQ4	219949	8975560-2	Socket: transistor
			Circuit Board Parts
		8983912-502	Circuit Board Assembly
C101			Not Used
C102	217061	737818-16	Capacitor: paper, 0.47 μf ±10%, 100 v

Symbol No.	Stock No.	Drawing No.	Description
C103,C104			Not Used
C105		735715-175	Capacitor: paper, 0.1 μf ±10%, 400 v
C106,C107		8811182-5	Capacitor: ceramic, 10,000 $\mu\mu f$ -20 +100%, 450 v
CR101	221603		Diode: type 651C4
CR102 to CR104	221599		Diode: type 1N429
Q101	221601		Transistor: type 2N1012
Q102	221602		Transistor: type 2N1040
Q103			Not Used
Q104	221602		Transistor: type 2N1040
Q105	221600		Transistor: type 2N333
			RESISTORS:
			Fixed, Composition - Unless otherwise specified
R101			Not Used
R102		82283-138	130 ohms, ±5%, ½ w
R103,R104			Not Used
R105		82283-136	110 ohms, ±5%, ½ w
R106			Not Used
R107		82283-69	3900 ohms, ±10%, ½ w
R108			Not Used
R109	221609	993008-110	wire wound, 28,000 ohms, ±5%, 10 w
R110 to R114			Not Used
R115		727834-153	560 ohms, ±5%, ½ w
R116		727834-137	120 ohms, ±5%, ½ w
R117		727834-158	910 ohms, ±5%, ½ w
R118	98956	8971860-106	variable, 1000 ohms, ±10%, 2 w
R119		727834-167	2200 ohms, ±5%, ½ w
R120		8983944-2	1 turn of .025 dia. magnetic wire on a 0.21 I.D.
R121		727834-156	750 ohms, ±5%, ½ w
XQ101,XQ102	222734	8707294-1	Socket: transistor
XQ103			Not Used
XQ104,XQ105	222734	8907294-1	Socket: transistor
			Miscellaneous:
	7960	845607-1	Knob: black
UNREGULATED CHASSIS (POWER SUPPLY), MI-26082-A			
C201,C202	221607	458558-58	Capacitor: electrolytic, 120 μf 200 v
C203	218426	458558-51	Capacitor: electrolytic, 150 μf 300 v
CR201,CR202	217351		Diode: type 1N1084
P201	207140	474619-1	Connector: male, 7 contact
R201,R202	221608	993008-38	Resistor: fixed, wire wound, 7.1 ohms, ±10%, 10 w
CENTERING CHASSIS, MI-26083-A			
C301,C302	218606	189335-6	Capacitor: electrolytic, 2000 μf 25 v
CR301,CR302	221606		Diode: type 1N1085
CR303	221603		Diode: type 651C4
P301	207139	475145-1	Connector: male, 9 contact
Q301	221605		Transistor: 2N458
Q302	221602		Transistor: 2N1040
R301,R302	221608	993008-38	Resistor: fixed, wire wound, 7.1 ohms, ±10%, 10 w
R303		90496-63	Resistor: fixed, composition, 1200 ohms, ±10%, 1 w
R304	221608	993008-38	Resistor: fixed, wire wound, 7.1 ohms, ±10%, 10 w
XQ301	219949	8975560-2	Socket: transistor

NOTES

280 VOLT POWER SUPPLY DC VOLTAGE REQUIREMENTS

Measurements made with Senior Voltohmyst WV-98A; all voltages are made with respect to chassis ground unless otherwise stated.

Measurement Conditions

E_o Regulated .... 280 volts

I_o Regulated .... 1.350 amperes

Point of Measurement		Voltage
Main Chassis		
Q1	E	0.57
	B	.75
	C	25.0
Q2	E	0.55
	B	0.75
	C	25.0
Q3	E	0.58
	B	.75
	C	25.0
Q4	E	.75
	B	.87
	C	24.5
C1	(−)	−29.5

Point of Measurement		Voltage
Circuit Board		
Q101	E	−19.5
	B	−19.5
	C	− 0.92
Q102	E	− 0.82
	B	− 0.92
	C	− 0.23
Q104	E	30.5
	B	30.0
	C	92.0
Q105	E	19.5
	B	20.0
	C	30.0
Across CR101		5.0
Jct. R115-R116-R109		31.0

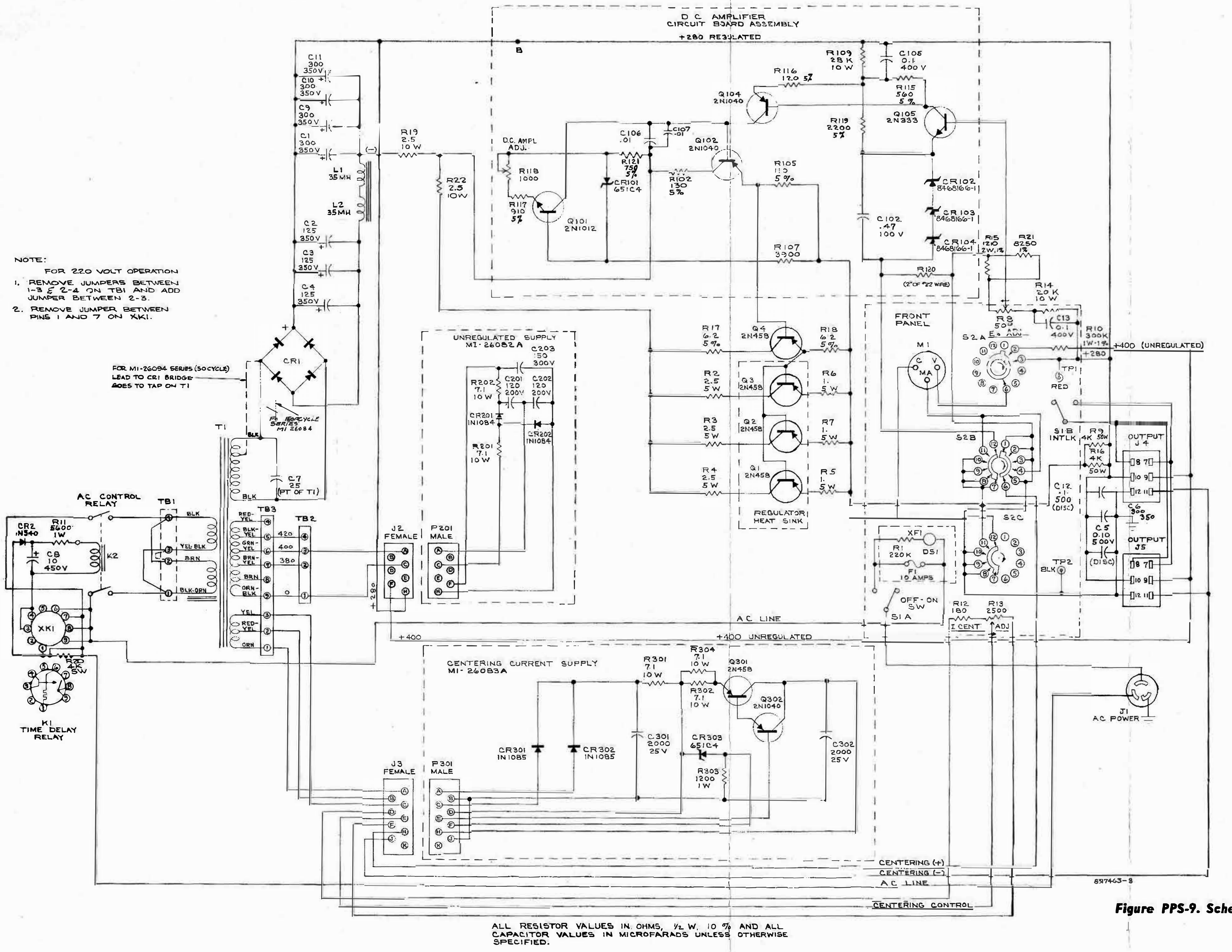
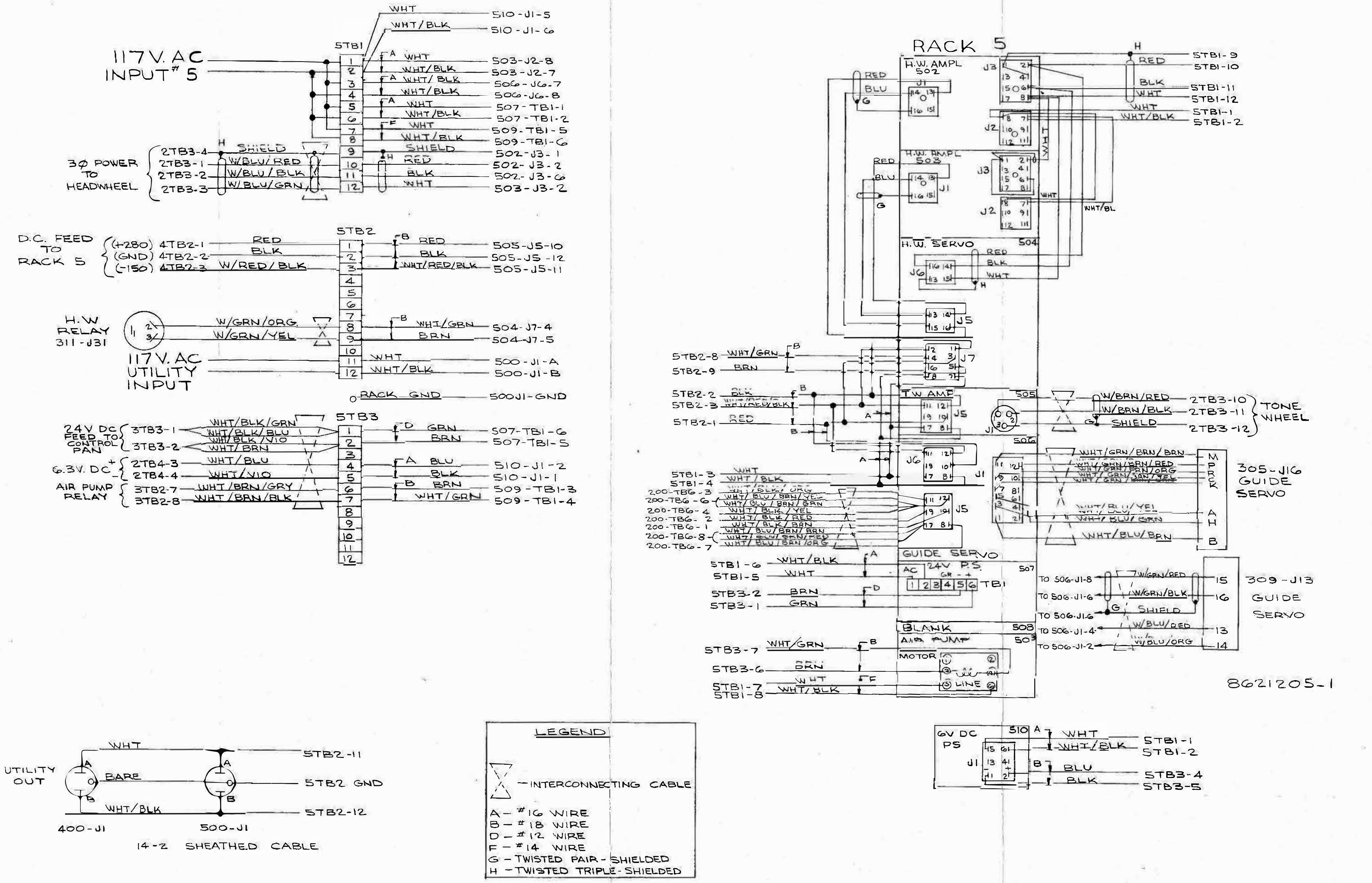


Figure PPS-9. Schematic Diagram, 280 Volt Power Supply

PARTS LIST

Symbol No.	Stock No.	Drawing No.	Description
			RACK #5 (8975565-503) 18
510-J1	18534	181494-4	Connector: male, 6 contact, chassis mtg.
5TB1 to 5TB3		449691-5	Board: terminal



Interconnection Diagram, Rack 5

Headwheel Servo

UNIT 504

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INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN N. J.

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WA 671

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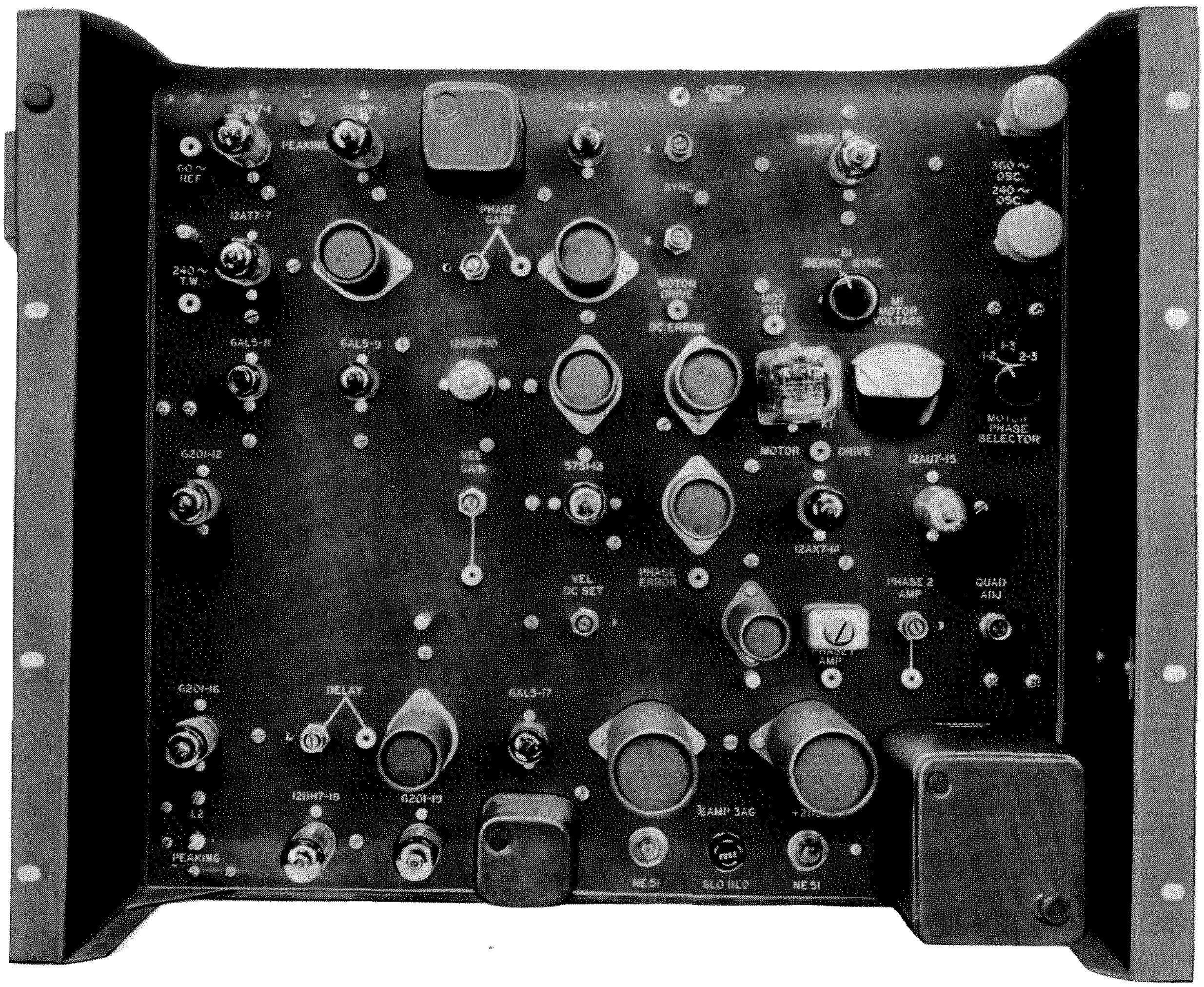


Figure HWS-1. Headwheel Servo

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles
(From circuit breaker No. 4)

DC: +280 volts, (from unit No. 410)
−150 volts, (from unit No. 405)

Input Signals

60 Cycle Reference Pulse: 4 volts P-P
(From Reference Generator unit 407)

240 Cycle Tonewheel Pulse: 4 volts P-P
(From Tonewheel Amplifier 505)

Output Signals

360 Cycle, 2 Phase
(To Servo Power Amplifiers units 502 and 503)

Tube and Diode Complement

4	6AL5	1	5751
2	12AT7	4	6201
2	12AU7	2	IN2071
1	12AX7	7	IN456
2	12BH7	1	IN458

Fuse Complement

1¾ Amp. Slo-blo

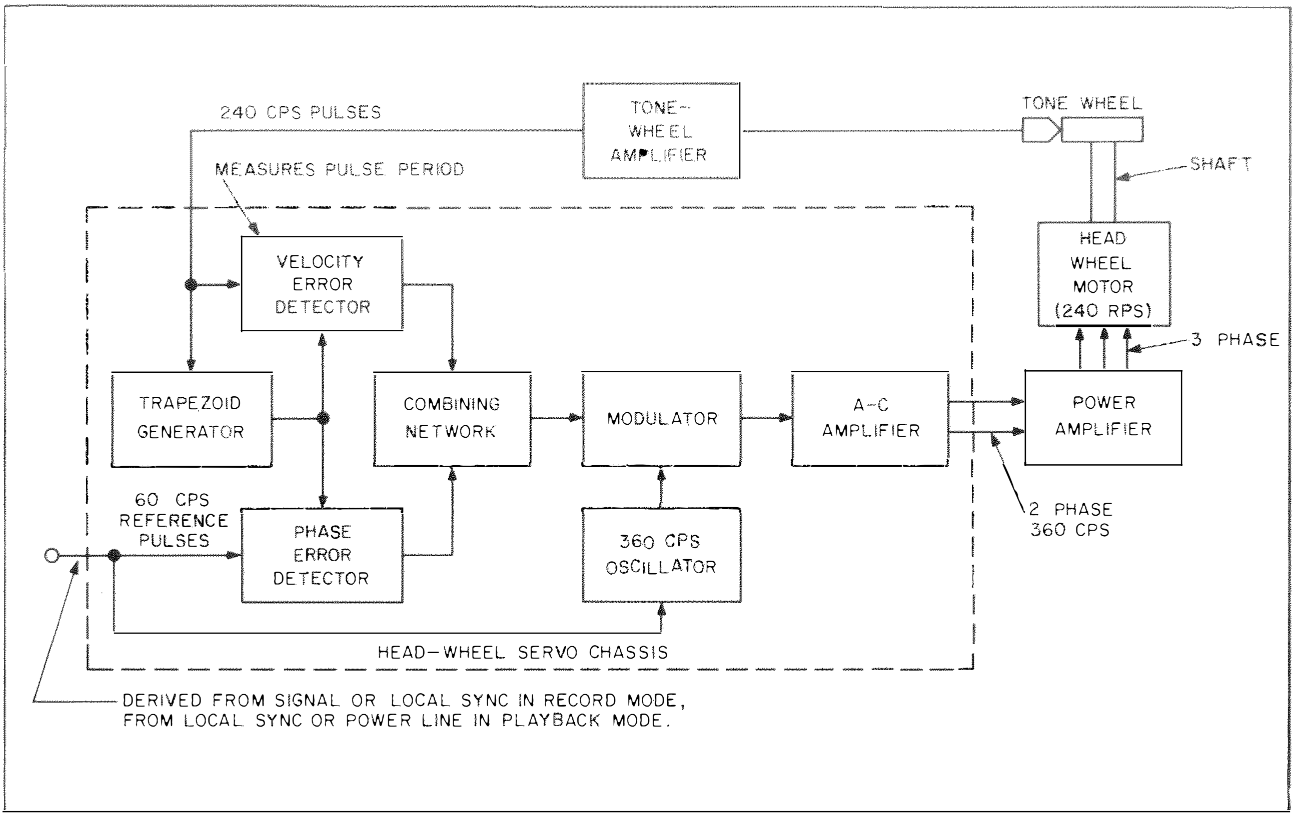


Figure HWS-2. Headwheel Servo Simplified Block Diagram

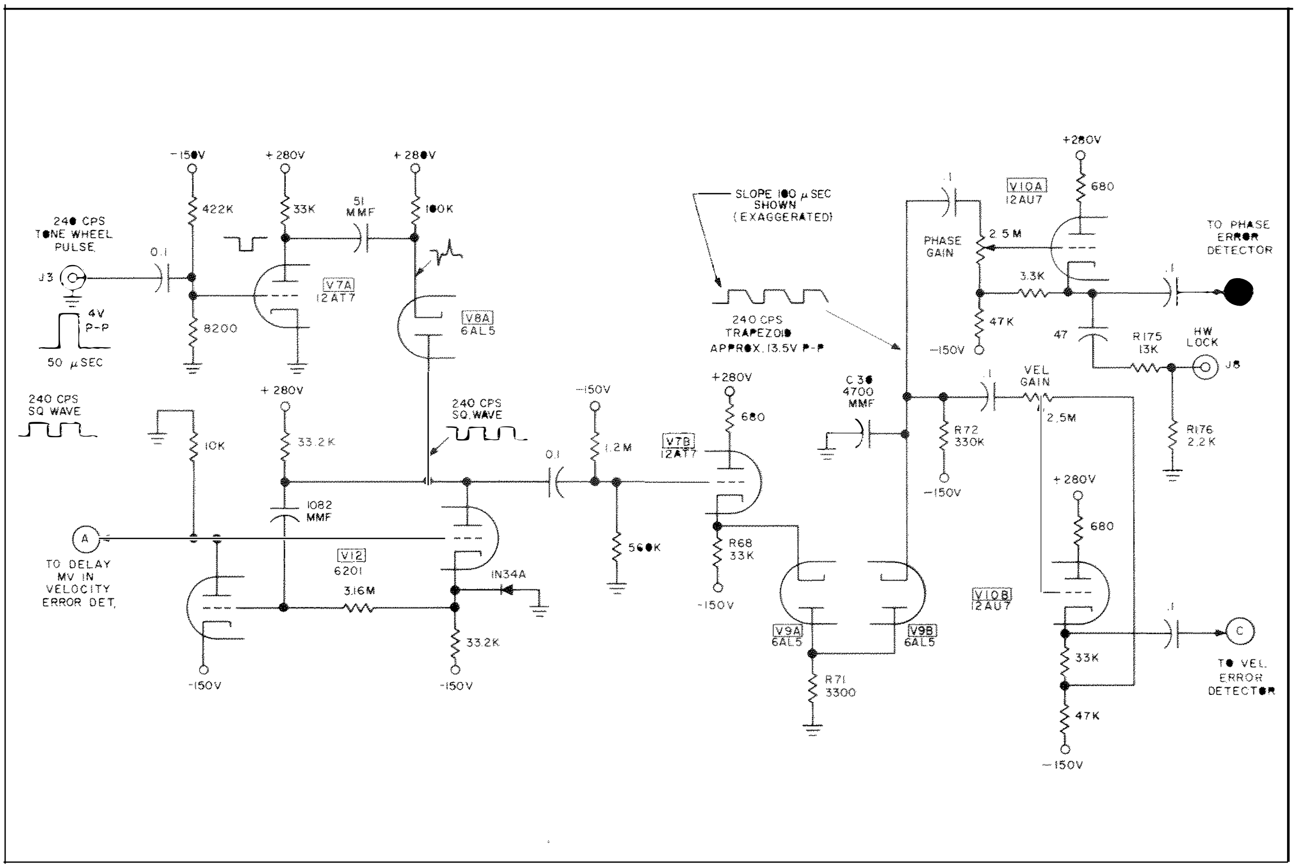


Figure HWS-3. Trapezoid Generator Simplified Schematic Diagram

DESCRIPTION

The Headwheel Servo system controls the speed of the headwheel motor in both the record and playback modes of operation. In both cases, the nominal speed of the headwheel motor is 240 revolutions per second, or 14,400 revolutions per minute.

In the record mode, it is required to make the headwheel speed in revolutions-per-second exactly four times the vertical scanning frequency (which is nominally 60 cycles-per-second). The timing reference for the headwheel servo in the record mode of operation is either the stripped sync pulses from the input video signal, obtained from the 2 x 1 switcher, or the sync pulses from the local generator. These sync pulses are converted into 60 cps pulses in the reference generator. The most practical way to control the headwheel speed is with a servo system in which an error detector compares the phase of a signal developed by a tonewheel attached to the headwheel motor against a reference pulse derived from the signal itself. This action assures that each television field period occupies exactly sixteen complete transverse tracks on the tape. (Note that each revolution of the headwheel produces four tracks, because of the four heads around the circumference of the wheel.)

In the playback mode, the speed of the headwheel motor determines the absolute value of the deflection frequencies (and all other frequency components) in the reproduced signal, so it is important that the headwheel speed be sufficiently constant so that the scanning frequencies fall within the tolerance limits suitable for broadcast transmissions. To assure such stability, the headwheel motor is controlled by the same servo system used for recording, but the reference signal compared with the tonewheel signal in the error detector and is derived either from the local sync generator (preferably) or from the Power line.

A simplified block diagram of the headwheel servo system is shown in figure HWS-2. The headwheel motor is a synchronous, hysteresis type designed for operation in the vicinity of 300 cycles per second. It is not operated in a synchronous mode in the TRT-1B tape recorder. It is supplied with 3-phase power at about 360 cycles per second, but its speed is held back to 240 revolutions per second by the servo system. This non-synchronous operating condition gives the servo system a good acceleration characteristic at 360 revolutions per second, but is held back by the fact that the servo system continuously delivers only enough power to exactly balance the load at a speed of 240 revolutions per second.

Control of the power supplied to the motor is achieved by a modulator which adjusts the level of a 360 cps signal in accordance with the output of the error detectors. The modulator operates at a relatively low power level, so therefore, is followed by a stage of feedback stabilized voltage amplification and two 70-watt power amplifiers. A pair of phase-shifting networks at the output of the servo chassis provide two signals 90 degrees apart in phase. The two phases are amplified separately by their respective power amplifiers, and then converted to 3-phase power through the use of Scott-connected transformers.

As shown in figure HWS-2, there are actually two error detectors in the headwheel servo system. Close control is achieved through the phase-error detector shown at the bottom, wherein a trapezoidal waveform derived from the tonewheel signal is sampled by pulses from the stable reference source. The precise control needed for normal operation results in a narrow lock-in range for the phase detector, so a wider-range velocity error detector is also used to reduce the time required for the servo system to assume control when operation is first started or momentarily interrupted. As will be shown later, the velocity detector operates by measuring the period of the tonewheel pulses. The output of both error detectors are combined in a mixing network and are used to control a single modulator, but the detectors are cross coupled in such a way as to minimize any tendency for the two detectors to supply conflicting information.

Circuit

Trapezoid Generator. The circuit that is used to generate a trapezoidal waveform from the tonewheel pulse is shown in figure HWS-3. The output signal of the tonewheel amplifier is applied to jack J3 (240 TW) and is amplified by a conventional voltage amplifier stage (V7A). The output of the voltage amplifier is applied to a differentiating network which converts the pulse into a pair of negative and positive "pips". The negative pip, corresponding to the leading edge of the input pulse, is coupled through diode V8A to trigger a multivibrator V12. This multivibrator is a stabilized monostable type. In the resting condition, V12A (left side) is conducting and V12B is cutoff. When a negative trigger pulse is applied to the plate (pin 1) of V12A the state of conduction reverses very rapidly, and the grid of V12A is driven below cut-off. Output signals are taken from both plates of the multivibrator. Stage V12A supplies a square wave to the velocity error detector. The output of V12B is coupled to a fixed bias cathode follower stage V7B, which in turn is connected to the trapezoid generator V9. The peak-to-peak signal applied to the grid of V7B is more than adequate to make the cathode swing from cutoff to a conducting state which

results in a cathode potential considerably more positive than ground.

The trapezoid waveform is generated across capacitor C30 at the cathode of V9B. When V7B is cutoff during the negative half cycles of the square waves, both sides of V9 conduct through the series resistors between −150 volts and ground. Resistors R68 and R72 are effectively in parallel, and having a net value of about 30 thousand ohms. This resistance is in series with R71, and forms a voltage divider across the −150 volt supply. The voltage across resistor R71 is approximately −15 volts. When the rising edge of the square wave signal occurs, however, cathode follower V7B begins to conduct and its cathode rises very rapidly to a voltage that is appreciably positive relative to ground. In so doing, it cuts off diode V9A, thus altering the original voltage divider arrangement, and causing the voltage across capacitor C30 to seek a new equilibrium at about a −1.5 volts (determined by the combination of resistors R71 and R72). The rate at which the circuit reaches this new equilibrium is determined by the time constant of resistor R71 and capacitor C30, which is about 15.5 microseconds. (This rate of change is very fast compared to the 4167 microsecond period of the 240 cps signal.) At the beginning of the next negative half cycle, V7B is cutoff, V9A is made conductive, and the voltage across R71 decreases to about −15 volts. The voltage across C30 is unable to change instantaneously, however, so diode V9B is cutoff as its plate is made more negative than its cathode. The voltage across C30 then proceeds to fall toward −150 volts at a rate determined by resistor R72 (a time constant of about 1550 microseconds). This action continues only until the cathode of V9B becomes slightly less negative than the plate, at which time V9B conducts and the output voltage again levels off at about −15 volts. The net result is that the input square wave is converted into a trapezoidal waveform with a relatively fast rise time but with a slow linear fall characteristic. The fall time is approximately 100 microseconds.

A pair of cathode followers, 10A and 10B, are used to supply isolated trapezoid signals to the two error detectors. Potentiometers in the grid circuits provide separate gain adjustments for the two servo loops. Voltage divider R175, R176 across the cathode circuit of V10A provides a signal for monitoring headwheel servo lock on the CRO monitor.

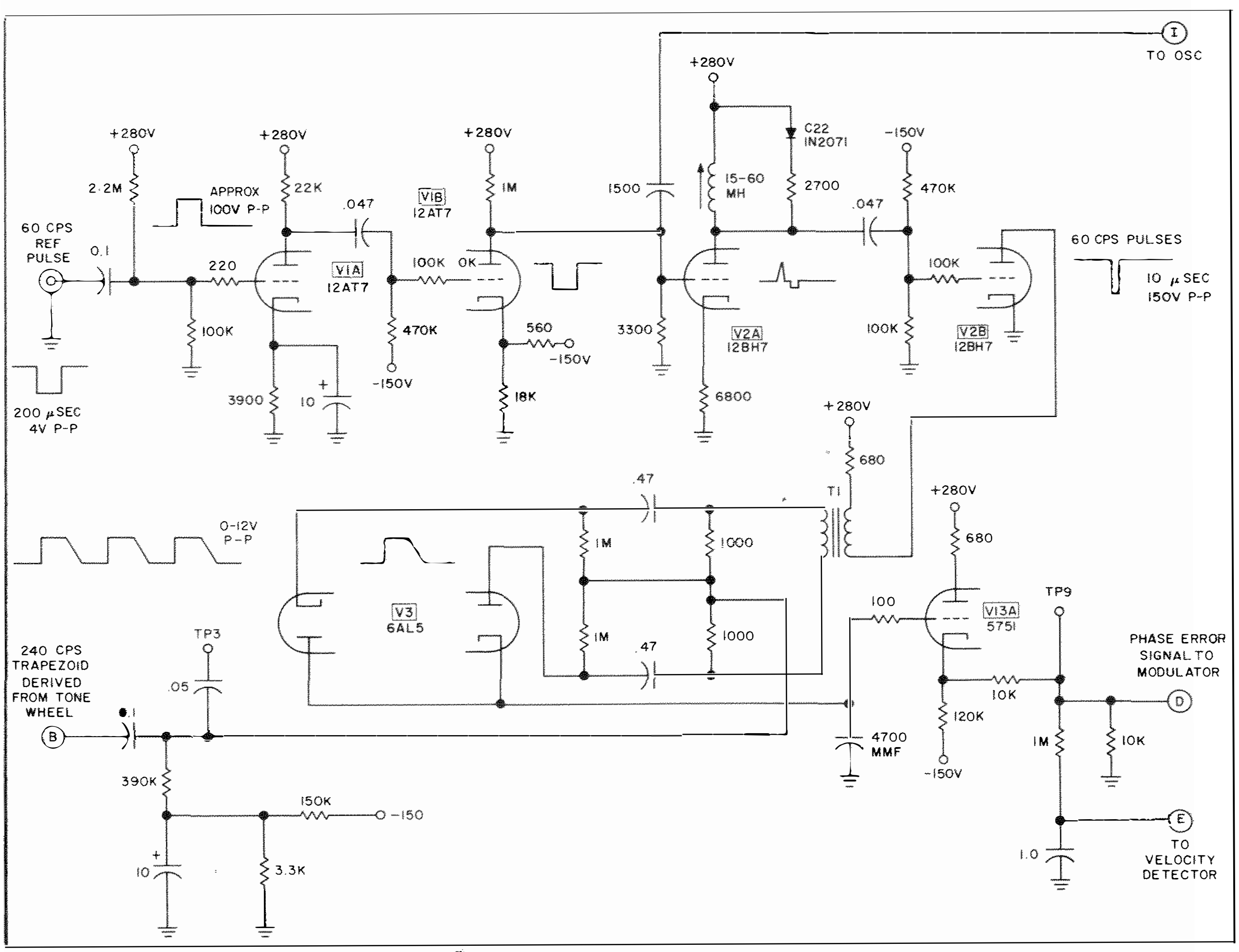


Figure HWS-4. Phase Error Detector Simplified Schematic Diagram

Phase Error Detector

The circuit of the phase error detector is shown in simplified form in figure HWS-4. As noted earlier, the function of this circuit is to develop an error signal through the comparison of a trapezoid signal with a series of 60-cycle pulses from a stable reference generator.

The upper row of stages of this circuit are used to generate sharp sampling pulses from the input reference pulses. The reference pulses are applied to the input of amplifier V1A where their amplitude is increased to about 100 volts peak-to-peak. The pulse tips are leveled off by the clipping action at the input of stage V1B; when the grid is driven far enough positive to draw grid current, the signal is sharply attenuated by the 100K resistor in series with the grid-to-cathode impedance. After amplification by V1B the pulses are fed to the pulse amplifier V2A. (The pulses are also coupled to the 360 cycle oscillator for locking purposes.) The plate load for stage V2A consists of a diode-damped ringing coil. When the current through tube V2A is cutoff by the leading edge of a reference pulse the coil produces a sharp positive spike corresponding to the first half-cycle of an oscillation at its self-resonant frequency. The oscillation does not continue, because the negative half-cycles are suppressed by diode CR2 shunted across the coil. (The 2700-ohm resistor in series with CR2 is necessary to permit most of the tube's current to be drawn through the coil, not through the diode, during the periods between pulses.) The diode also serves to suppress the negative spike that would normally be produced at the trailing edge of the reference pulse. The rounded top of the pulse delivered by the ringing coil is flattened by grid clipping at the input of V2B, which drives a phase detector through transformer T1. As noted on the diagram, the sampling pulse is only about 10 microseconds wide, and is raised to the relatively high level of about 150 volts peak-to-peak.

The phase detector stage, V3, is a close relative of the familiar double-diode clamping circuit. The two diodes are normally non-conductive except during the very brief sampling intervals corresponding to the peaks of the pulses delivered by the transformer. During the sampling (or clamping) intervals, the charge on the 4700 mmf capacitor is adjusted to make the output voltage nominally equivalent to the voltage occurring at that instant at the center-tap of the network on the opposite side of the diodes. The voltage across the 4700 mmf capacitor remains reasonably constant between clamping intervals, because when the diodes are open the charge on the capacitor can be altered only through high-impedance leakage paths. The signal applied to the center-tap of the clamper network is the 240-cps trapezoid waveform derived from the tonewheel signal. Provision is made for adding a d-c component to the waveform so as to adjust the absolute voltage at the mid-point of the slope on the trapezoid to a reasonable level for the following modulator.

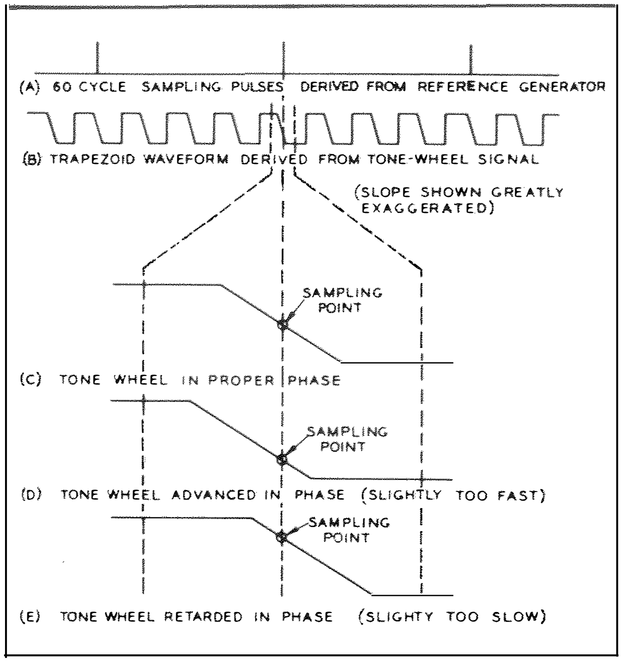


Figure HWS-5. Sketch of Operation of Phase Error Detector

The operation of the phase detector circuit is illustrated by the waveform sketches in figure HWS-5. Only every fourth cycle of the trapezoid waveform is actually sampled, because the reference pulses occur only at a 60 cps rate. When the headwheel is rotating at the proper speed, the sampling (or clamping) instant should occur exactly at the midpoint of the slope on the trapezoid waveform, as shown at (C). If the motor tends to run slightly too fast, the apparent phase of the trapezoid will be advanced relative to the reference pulses so the sampling will occur at a lower point on the waveform, and the error signal output will be reduced. This reduced-level error signal will reduce the power supplied to the motor so as to restore it to the proper speed. In similar fashion, a tendency for the motor to run too slow will cause the error signal to increase in voltage because of the retarded phase of the trapezoid signal, and the increased error signal will increase the power supplied to the motor to drive it at the correct speed.

The final stage shown in figure HWS-4, V13A, is a cathode follower which supplies low-impedance

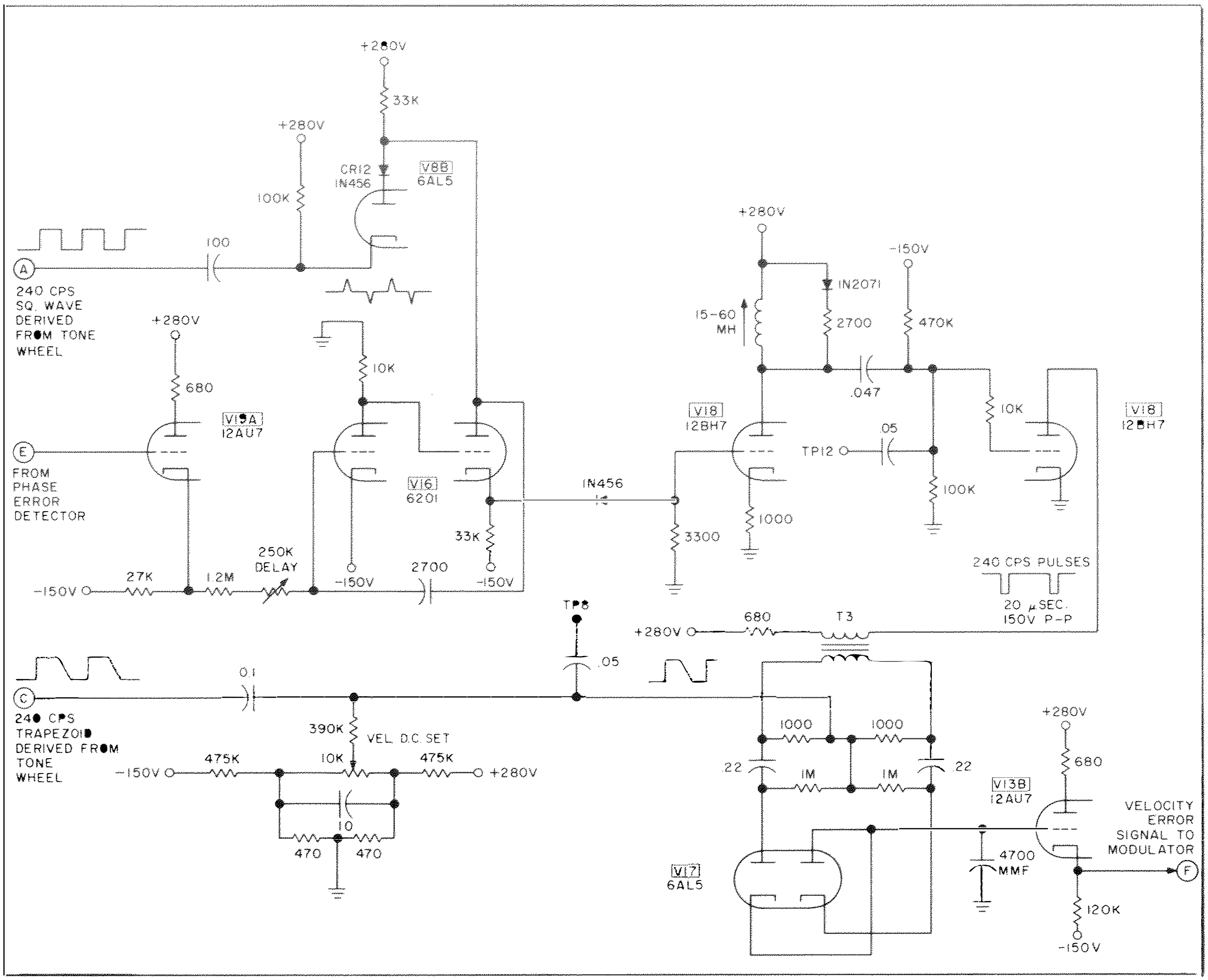


Figure HWS-6. Velocity Error Detector Simplified Schematic Diagram

drive for the modulator. A second output from V13A is directed to the velocity error detector through an RC integration network. The purpose of this output is to modify the operation of the velocity error detector so that it does not conflict with the phase error detector.

Velocity Error Detector

The velocity error detector, shown in slightly simplified form in figure HWS-6 is quite similar to the phase error detector, but the sampling pulses which operate the clamp-type detector are derived from a 240-cps square wave instead of from the 60-cps reference pulses. The input square waveform V12 is differentiated, and the negative-going "pips" are coupled through diodes V8B and CR12 to trigger V16, a stabilized multivibrator. Sharp sampling pulses are derived in synchronism with the falling edges of the pulses produced at the cathode of V16B by the ringing coil in the plate circuit of the left side of V18. The functions performed by the two sections of V18 are identical to those previously discussed for V2A and V2B. Phase detector V17 is also identical to stage V3. As in the case of the phase error detector, a cathode follower, V13B, is used at the output to provide a driving point of reasonably low impedance for the modulator.

The operation of the velocity error detector is best explained with the aid of the waveform sketches in figure HWS-7. At 240 cps the sampling pulses used in the velocity error detector are actually delayed approximately one full period by virtue of the fact that the two multivibrators are triggered in series to produce them (the electrical time constant of the two multivibrators determine the 240 cycle sampling period). The net result is that the detector is keyed at the center of the trapezoid slope when the motor is running at 240 cycles. When the motor speed differs from 240 cycles the detector is keyed in at a different point on the trapezoid slope; hence, the voltage at the detector output is a linear function of the motor

speed within the frequency range of 232 to 247 cycles. The width of the pulse produced by the first multivibrator is adjusted to make the square wave as symmetrical as possible, and the width of the pulses produced by the second are adjusted to make their trailing edges coincide with the mid-points of the slopes in the trapezoid waveform when the headwheel is operating at exactly 240 rps. Once these adjustments are made, the relative phase of the sampling pulses and the trapezoid signal will vary slightly if the headwheel is not running at the proper speed. If the headwheel runs slightly too fast, for example, the period of the trapezoid waveform is shortened slightly, causing the sampling point in the detector to slide down the waveform, thus generating a negative error signal. In effect, the detector is actually measuring the period between successive tonewheel pulses. The pull-in range of this detector is greater than that of the phase error detector, and it develops a useful error signal as soon as the tonewheel pulses first appear.

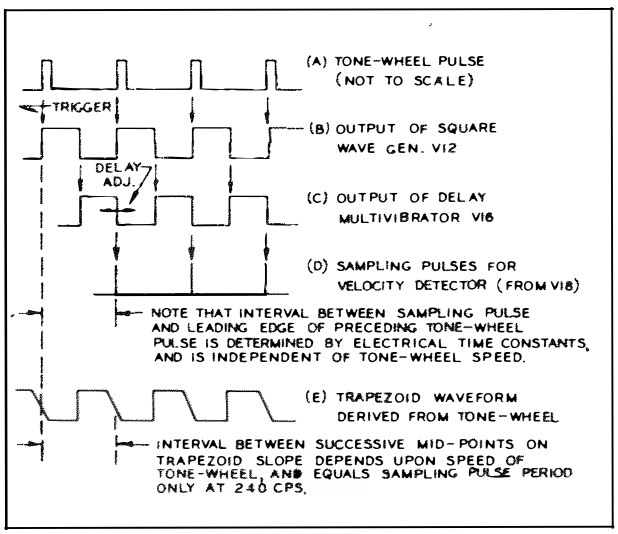


Figure HWS-7, Sketch of Operation of Velocity Error Detector

Cathode follower V19A, coupled to the pulse-width-determining time constant in multivibrator V16, is the means by which the output of the phase error detector modifies the operation of the velocity error detector. This coupling effectively increases the pull-in range of the phase loop and its dynamic range to load variations. Since the phase error signal is coupled to the grid of V19A through a 2 second time constant, the higher frequency components in the phase error are attenuated, and produce less effect than the lower frequency components. Since the dc-phase-error signal is amplified about 18 db, the bandwidth of this loop is about 0.25 radians per second. To illustrate the manner in which this loop compensates for load variations note the position of the sample pulse in the phase detector when the motor load is increased from 30 to 60 volts. Without the cross coupling loop, the voltage output of the detector must increase by a factor of 10 to provide the 2 to 1 increase in drive to the modulator. With the nominal phase gain of 8 volts peak-to-peak, the phase loop would lose lock since it has a maximum range of 8 volts. However, with the cross coupling loop operating, a change of one volt error signal at the phase detector will produce the desired increase in modulator drive and the phase loop sampling point is still within 20% of its center position. The same effect is present when the motor is locking in phase but it is not as pronounced since the cross coupling loop has a limited bandwidth.

Oscillator and Modulator

The oscillator V5, (refer to figure HWS-8) is a free running multivibrator that is locked to the 60-cycle reference signal by the negative going trigger pulse from the plate (pin 2) of stage V1. The output signal of the oscillator can be observed at test point TP2. It is a squarewave pulse with a frequency of 360 cycles and an amplitude of 75 volts peak-to-peak when the SERVO-SYNC switch (S1) is in the SERVO position. When switch S1 is in the SYNC position the oscillator frequency is 240 cycles. The oscillator output is applied to the modulator consisting of crystal diodes CR9 and CR10.

The modulator converts the dc error signal into a 360-cycle square wave, the amplitude of which is proportional to the amplitude of the dc error signal. An analogy can be drawn between the operation of the modulator and the operation of a relay with the oscillator signal acting as the control signal turning a dc voltage on and off. The positive dc error signal is applied to diode CR10 causing it to conduct thereby generating the leading edge of a squarewave. When diode CR9 conducts (on the negative half-cycle of oscillation) it places a negative bias on the plate of diode CR10; thereby placing it in an open circuit condition. Therefore the dc voltage across R33 alternates between the dc error signal and ground at a 360 cps rate. This results in a 360-cycle square wave at the output of the modulator (TP6) which is proportional to the dc error signal fed into the modulator. A negative dc error signal would produce no output because diode CR10 would not conduct when a negative voltage is applied to its plate. The squarewave output signal from the modulator is applied to the motor drive potentiometer R92 which sets the loop gain for the servo system. The signal from the potentiometer is applied to relay K1 which disconnects the drive to the motor when the tape recorder is in the stop mode.

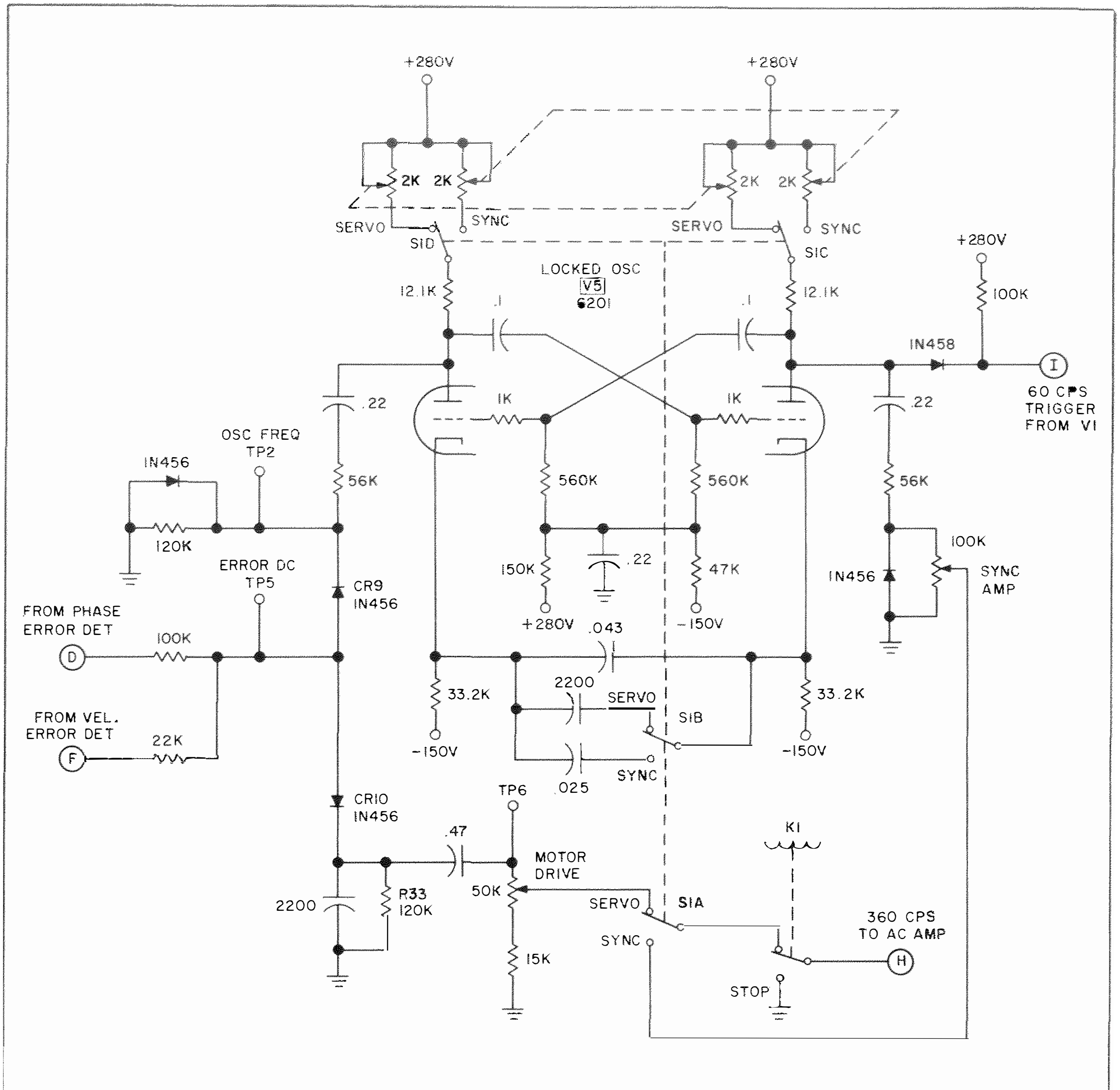


Figure HWS-8. Oscillator and Modulator Simplified Schematic Diagram

AC Amplifier

The a-c amplifier V14 (refer to figure HWS-16) increases the signal to the level required to drive the Headwheel Power Amplifiers. The 360-cycle square-wave signal is applied to the grid (pin 2) of V14 through relay K1. The signal amplitude is increased by the two stage voltage amplifier. The amplifier output signal is applied to a tuned LC filter the output of which is a 360-cycle sine wave; this filter is tuned to 360-cycles by adjusting inductor L3. The filter output is fed to the cathode follower V15A.

The output cathode follower, V15A, has two-phase-shifting networks tied to its cathode. The voltage between the junction of resistors R106 and R172, (TP10) and chassis ground leads the voltage at the cathode of V15A by about 45 degrees. The voltage between resistor R107 (TP11) and chassis ground lags the voltage at the cathode of V15A by about 45 degrees; so that, a 90 degree phase shift exists between the two output voltages. The QUAD ADJUST control (R108) of the upper network permits adjustment of the phase difference to exactly 90 degrees at 360 cycles. For proper operation of the Scott-connected transformers, see figure SA2 of the servo power amplifier section of the instruction book.

MAINTENANCE

Setup Adjustments

Proper operation of the headwheel servo system depends upon the correct adjustment of the system controls. Before making the headwheel servo setup adjustments be sure that the headwheel power amplifiers (units 502 and 503) are properly adjusted. With a Tektronix Type 535 oscilloscope or equivalent, make the headwheel servo adjustments as outlined in the following table.

SETUP

Step No.	*Figure No.*	*Connect Scope To**	*Procedure*
1			Set the DELAY control (R114) to its mid-position.
2			Set the PHASE GAIN control (R27) full counterclockwise.
3			Set the VEL GAIN control (R83) fully clockwise.
4			Set the MOTOR DRIVE control (R92) fully clockwise.
5			Set the PHASE 2 AMP control (R107) fully clockwise.
6			Press the control panel STOP button.
7	HWS-9A	DC ERROR (TP-5)*	Adjust VEL DC SET control (R130) for 3 volts peak-to-peak.
8	HWS-9B	"A" input to 60 cycle reference	Check for an amplitude of 4 ±0.5 volts peak-to-peak.
9	HWS-9C	"A" input as in step 8 "B" input to LOCKED OSC (TP-1)	Place the SERVO-SYNC switch in SYNC. Adjust 240 cycles OSC. control (R34) for a locked 4:1 count (exactly 4 cycles on "B" trace for every cycle on "A" trace).**
10	HWS-9C	Same as Step 9	Determine the lock-in range of the 240 cycles OSC. control (R34) by turning the control first in one direction until the pattern falls out of 4:1 lock and then in the opposite direction until the signal again falls out of lock. Then set the control in the center of the lock-in range (halfway between the two extreme positions).
11	HWS-9D	Same as Step 9	Place the SERVO-SYNC switch (S1) in SERVO. Adjust 360 cycles OSC. control (R35), for a locked 6:1 count (exactly 6 cycles on "B" trace for every cycle on the "A" trace). **Then determine lock-in range of the 360 cycle OSC. control (as in step 10) and set the control in the center of the lock-in range.
12			Press the control panel STANDBY button and note the motor starting voltage on the MOTOR VOLTAGE meter (reading obtained after initial kick of needle and just before needle drops to operating value). If necessary, adjust the VEL DC SET control (R130) until the starting voltage is 70 volts.
13	HWS-9E	VEL GAIN* (TP-8)	Check for an amplitude of 11 ±0.5 volts p/p. This value is usually obtained in the full clockwise position of the VEL GAIN control, R83, (pre-set position). If the amplitude is too large reduce the control setting†
14	HSW-9F	PHASE 1 AMP (TP-10)	Adjust inductor L3 (directly above TP-10) for minimum distortion of the 360 cycle sine wave.
15			Check the amplitude of each of the three motor-voltage phases by placing the PHASE SELECTOR switch in positions 1-2, 1-3, and 2-3, and observing the MOTOR VOLTAGE meter. If the amplitudes are unequal adjust the PHASE 2 AMP control (R107), and QUAD ADJ control (R108) for the best amplitude balance. At the end of these adjustments the three voltages should be between 30 and 35 volts and within about 2 volts of each other.
16	HWS-9G	"A" input to 60 cycles REF (TP-1) "B" input to DC ERROR (TP-5)	Adjust the MOTOR DRIVE control (R92) for 1.4 volts p-p.‡

SETUP (Continued)

Step No.	*Figure No.*	*Connect Scope To**	*Procedure*
17	HWS-9H	"A" input same as step 16 (TP-1)	Adjust the PHASE GAIN control (R27) to its mid-position.
		"B" input to VEL GAIN (TP-8)	Adjust the DELAY control (R114) until the 240 cycle square wave on the "B" trace locks with the 60 cycle pulse on the "A" trace (4:1 lock).
18	HWS-9I	"A" input same as step 16 (TP-1) "B" input to PHASE GAIN (TP-3)	Adjust the PHASE GAIN control (R27) for 7 volts p-p.
19	HWS-9I	Same as Step 18	Check to see that the pip is locked on the slope of every fourth trapezoid waveform. Touch up the DELAY control (R114) until the pip is locked at a point 10% below center.§

* Lock scope sweep to internal sync for steps 1 and 13 only. For all other steps lock the sweep to 60 cycle REF (TP-1).

** In steps 9 and 10, the oscillator may lock in undesired modes. Make certain to adjust the oscillator controls for the exact ratio desired (4:1 in step 9, 6:1 step 10).

† As shown in figure HWS-9E, the sampling pip should be locked on the trapezoid slope about 25% below center. This indicates that the velocity loop is functioning correctly.

‡ In the STOP mode, the dc error voltage (adjusted in step 7) is 3 volts. In STANDBY, with the motor running and the velocity loop locked in, the voltage drops to 1.4 volts. In the PLAY mode, with the motor under load, the voltage rises to 1.7 volts p-p.

§ The pip is set below the center to allow for the effect of the tape load during recording and playback, which will move the pip to the center.

Normal Reading of MOTOR VOLTAGE Meter During Record and Playback

During record and playback, under normal conditions, the MOTOR VOLTAGE meter will usually read between 35 and 45 volts and may go as high as 50 volts. If the reading is greater than 50 volts, check for an excessive load on the headwheel motor. The condition may be due to excessive vacuum guide pressure or a tape which gunks the headwheel.

Synchronous Operation of the Headwheel Motor Under Emergency Conditions.

A locked 240 cycle oscillator on the headwheel servo chassis permits driving the headwheel motor synchronously, as an emergency measure, if difficulties are encountered in operation of the servo loop. For synchronous operation place the SERVO-SYNC switch (S1) in the SYNC position and adjust the SYNC AMPLITUDE control (R152) until the MOTOR VOLTAGE meter reads about 70 volts and the jitter of the meter needle is less than three (3) volts.

Trouble Shooting

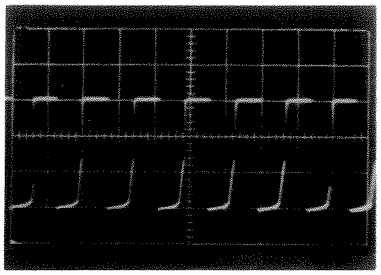
For proper operation of the headwheel servo system the velocity loop must lock before the phase loop will lock. To check for velocity loop lock, connect an oscilloscope to test point TP8 (VEL GAIN). The waveform should be as shown in figure HWS-11I. If the proper indication is obtained at TP8 connect the oscilloscope to test point TP1 (60 REF) the waveform should be as shown in figure HWS-9B. If the correct indication is not obtained check the reference generator.

If the correct waveform is not obtained at TP8, connect the oscilloscope to test point TP4 (240 TW); the waveform should be as shown in figure HWS-11B. (No waveform at TP4 indicates possible trouble in the tonewheel amplifier). Check to see if the headwheel motor is running. If the motor is not running place the SERVO-SYNC switch in the SYNC position. (This opens the servo loop.) If the headwheel motor still fails to run, check for proper output at TP10 (PHASE 1 AMPLITUDE) and TP11 (PHASE 2 AMPLITUDE), see figures HWS-13I and HWS-13J respectively. If the proper output is not obtained at test point TP10 and TP11, check for proper operation of the 360 cycle oscillator V5 at test point TP2 (LOCKED OSC.), see figure HWS-13C. If the proper output is obtained at TP2, check the servo power amplifiers, units 502 and 503, for correct output. The amplifier output voltage can be monitored on the headwheel servo MOTOR VOLTAGE meter; the readings should be approximately 70 volts each.

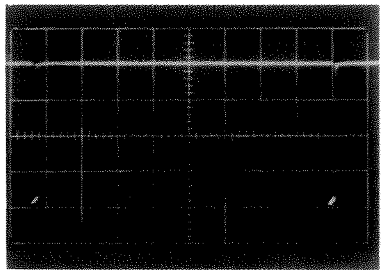
Waveforms and Voltages

Figures HWS-9 to HWS-14 show typical waveforms obtained throughout the unit for use as an aid in trouble shooting. All waveforms were obtained with a Tektronix Type 535 A Oscilloscope having a 10:1 attenuator probe (11.5 μf), and with the tape recorder in SETUP.

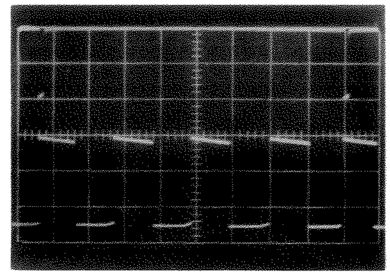
The Voltage Table adjacent to the schematic diagram (figure HWS-16) indicates typical tube socket voltages taken with respect to chassis ground, and were measured with a vacuum-tube voltmeter (VTVM). All voltages are dc unless otherwise noted.



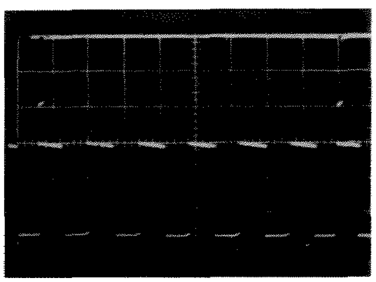
A. DC ERROR (TP5)
Amplitude: 1 volt/cm



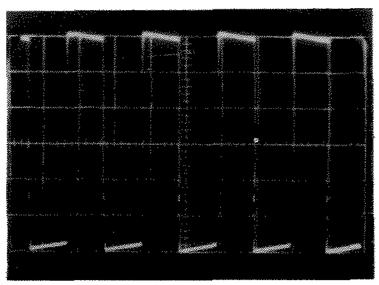
B. 60 ~ REF (TP1)
Amplitude: 1 volt/cm



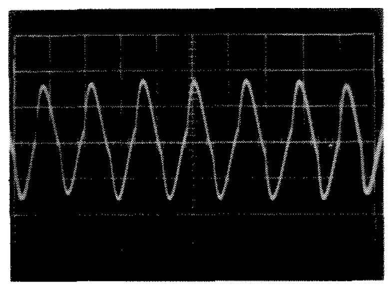
C. (1) 60 ~ REF (TP1)
(2) LOCKED OSC (TP2)
Amplitude: 20 volts/cm
Switch S1 in SYNC
240 ~ OSC control set
for 4:1 lock (240 cps)



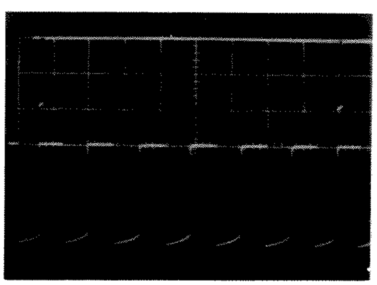
D. (1) 60 ~ REF (TP1)
(2) LOCKED OSC (TP2)
Amplitude: 20 volts/cm
Switch S1 in lock
360 ~ OSC control set
for 6:1 lock (360 cps)



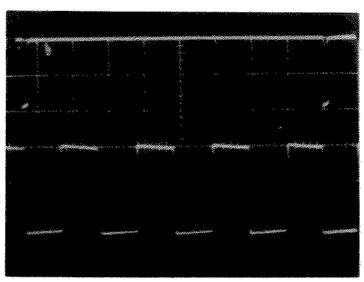
E. VEL GAIN (TP8)
Amplitude: 2 volts/cm



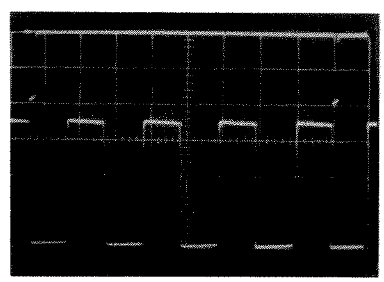
F. PHASE 1 AMP (TP10)
Amplitude: 0.5 volt/cm



G. (1) 60 ~ REF (TP1)
(2) DC ERROR (TP5)
Amplitude: 0.5 volt/cm

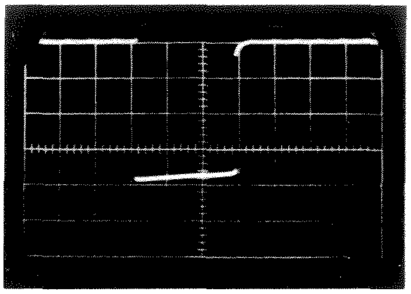


H. (1) 60 ~ REF (TP1)
(2) VEL GAIN (TP8)
Amplitude: 5 volts/cm

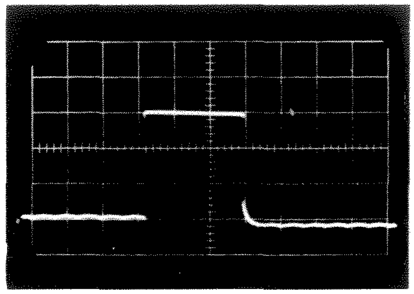


I. (1) 60 ~ REF (TP1)
(2) PHASE GAIN (TP3)
Amplitude: 2 volts/cm

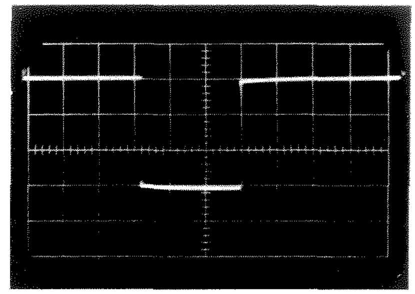
Figure HWS-9. Waveforms for Use with Setup Procedure (Sweep Rate: 2000 usec/cm)



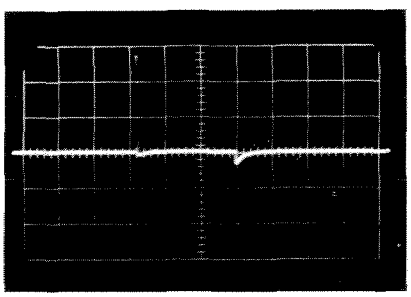
A. 60 ~ REF (TP1)
Sweep Rate: 100 usec/cm
Amplitude: 1.0 volt/cm



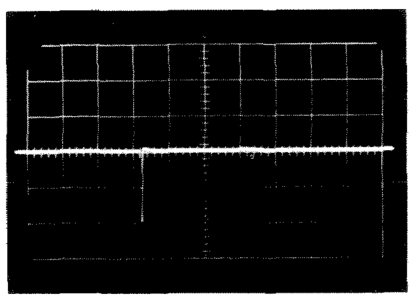
B. V1 Plate (pin 1)
Sweep Rate: 100 usec/cm
Amplitude: 20 volts/cm



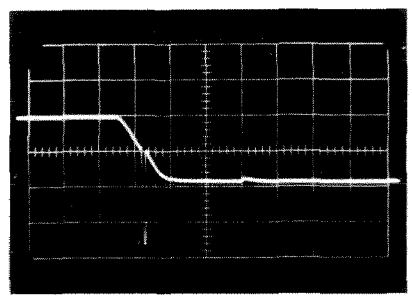
C. V1 Plate (pin 6)
Sweep Rate: 100 usec/cm
Amplitude: 10 volts/cm



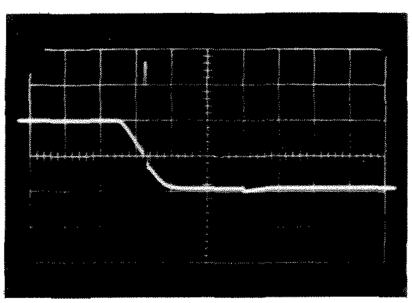
D. V2 Plate (pin 1)
Sweep Rate: 100 usec/cm
Amplitude: 20 volts/cm



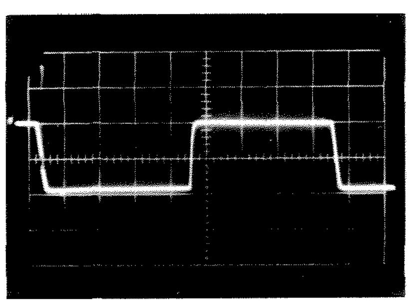
E. V2 Plate (pin 6)
Sweep Rate: 100 usec/cm
Amplitude: 100 volts/cm



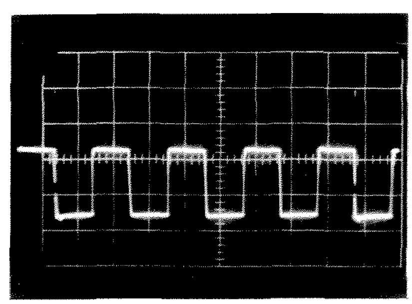
F. V3 Cathode (pin 5)
Sweep Rate: 100 usec/cm
Amplitude: 5 volts/cm



G. V3 Plate (pin 7)
Sweep Rate: 100 usec/cm
Amplitude: 5 volts/cm

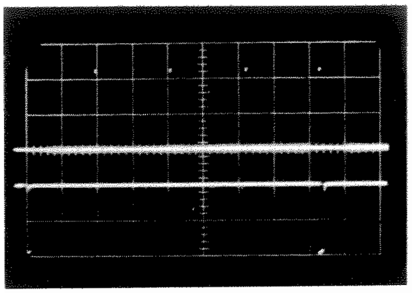


H. V3 Plate (pin 7)
Sweep Rate: 500 usec/cm
Amplitude: 5 volts/cm

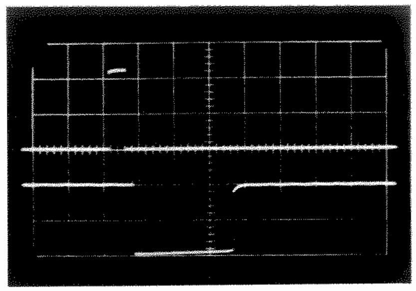


I. V3 Plate (pin 7)
Sweep Rate: 2000 usec/cm
Amplitude: 5 volts/cm

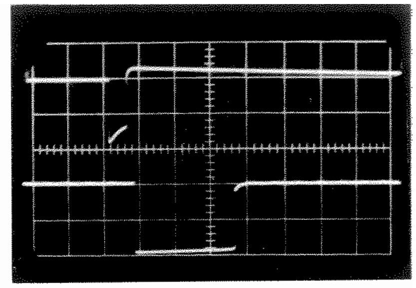
Figure HWS-10. Typical Waveforms



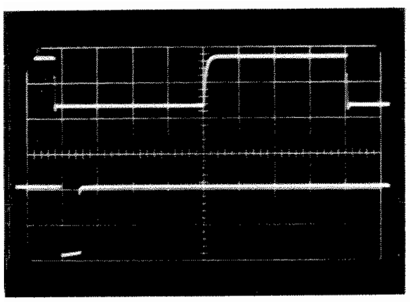
A. 240 ~ T.W. (TP4)
Sweep Rate: 2000 usec/cm
Amplitude: 2 volts/cm



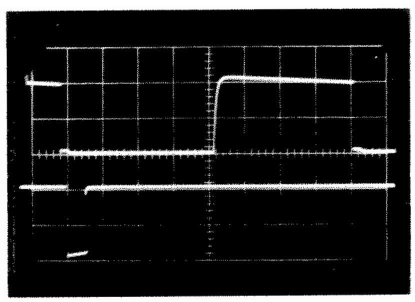
B. 240 ~ T.W. (TP4)
Sweep Rate: 100 usec/cm
Amplitude: 2 volts/cm



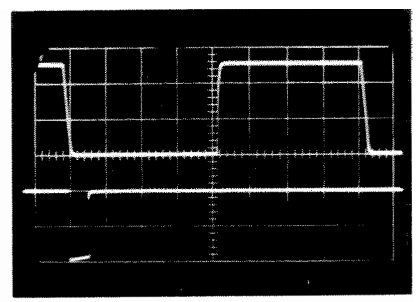
C. V7 Plate (pin 1)
Sweep Rate: 100 usec/cm
Amplitude: 100 volts/cm



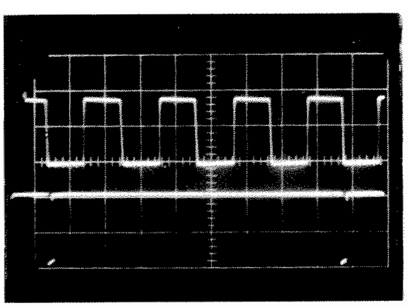
D. V7 Grid (pin 7)
Sweep Rate: 500 usec/cm
Amplitude: 100 volts/cm



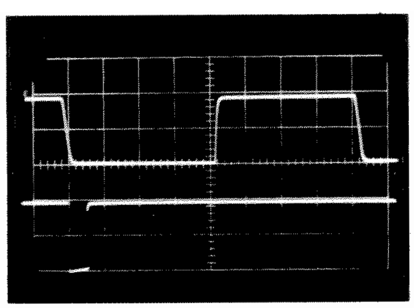
E. V7 Cathode (pin 8)
Sweep Rate: 500 usec/cm
Amplitude: 20 volts/cm



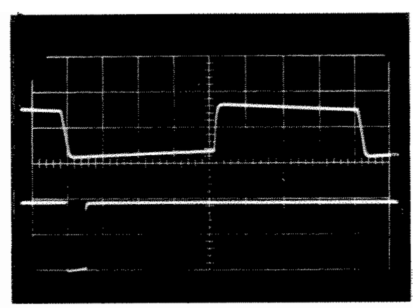
F. V9 Cathode (pin 5)
Sweep Rate: 500 usec/cm
Amplitude: 5 volts/cm



G. PHASE GAIN (TP3)
Sweep Rate: 500 usec/cm
Amplitude: 5 volts/cm

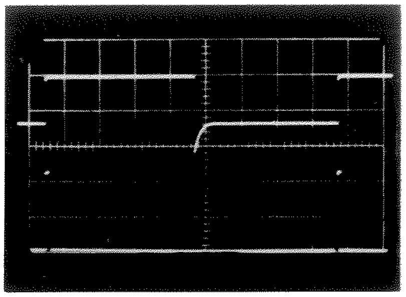


H. PHASE GAIN (TP3)
Sweep Rate: 2000 usec/cm
Amplitude: 5 volts/cm

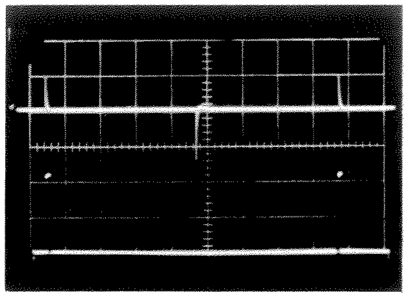


I. VEL GAIN (TP8)
Sweep Rate: 500 usec/cm
Amplitude: 10 volts/cm

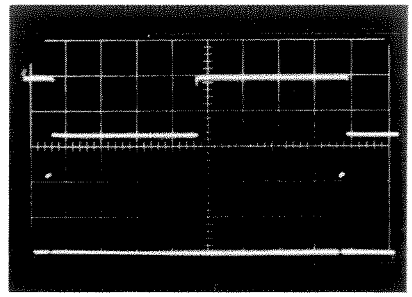
Figure HWS-11. Typical Waveforms
(Dual Trace—60-cycle Reference on Bottom)



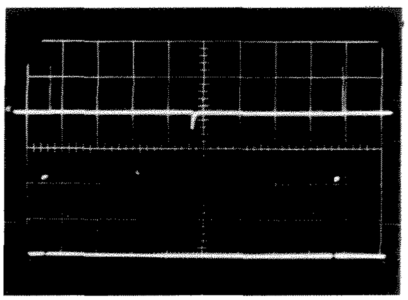
A. V12 Plate (pin 1)
Sweep Rate: 500 usec/cm
Amplitude: 50 volts/cm



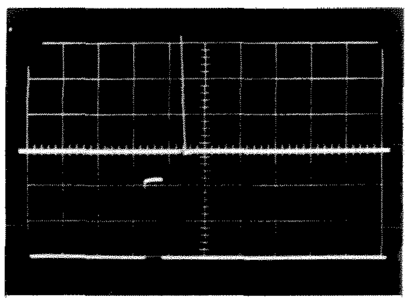
B. V8 Plate (pin 1)
Sweep Rate: 500 usec/cm
Amplitude: 50 volts/cm



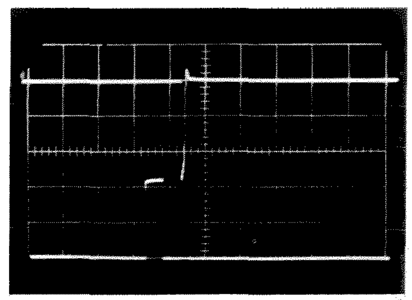
C. V16 Cathode (pin 8)
Sweep Rate: 500 usec/cm
Amplitude: 10 volts/cm



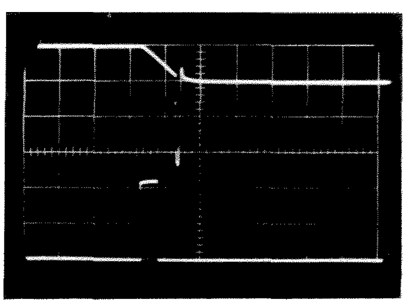
D. V18 Plate (pin 1)
Sweep Rate: 500 usec/cm
Amplitude: 50 volts/cm



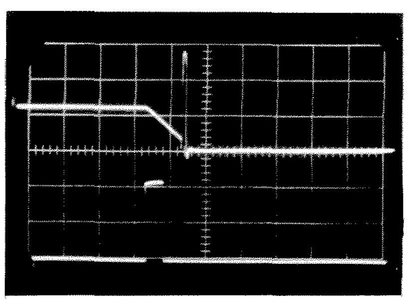
E. DELAY (TP12)
Sweep Rate: 100 usec/cm
Amplitude: 20 volts/cm



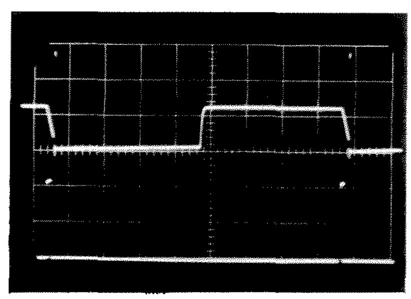
F. V18 Plate (pin 6)
Sweep Rate: 100 usec/cm
Amplitude: 100 volts/cm



G. V17 Cathode (pin 5)
Sweep Rate: 100 usec/cm
Amplitude: 10 volts/cm

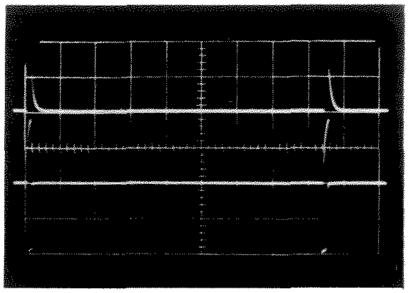


H. V17 Cathode (pin 1)
Sweep Rate: 100 usec/cm
Amplitude: 10 volts/cm

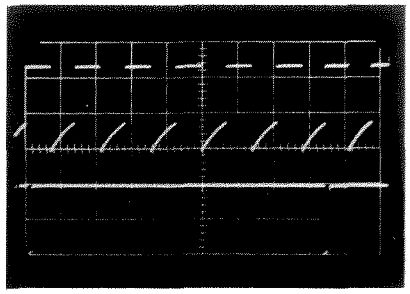


I. V17 Cathode (pin 1)
Sweep Rate: 500 usec/cm
Amplitude: 10 volts/cm

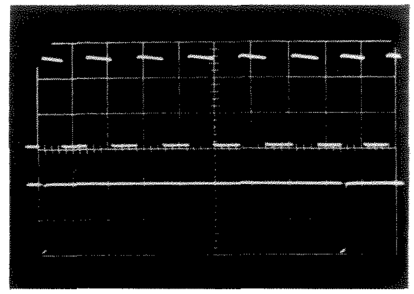
Figure HWS-12. Typical Waveforms
(Dual Trace—240 TW Reference on Bottom)



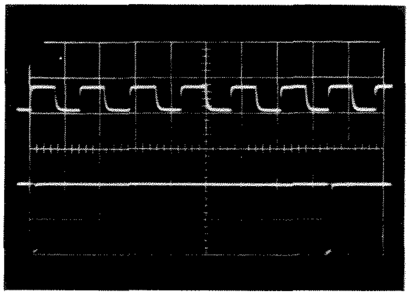
A. Diode CR11 (Cathode)
Sweep Rate: 2000 usec/cm
Amplitude: 20 volts/cm



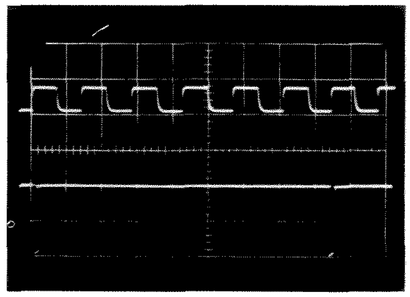
B. V5 Plate (pin 1)
Sweep Rate: 2000 usec/cm
Amplitude: 50 volts/cm



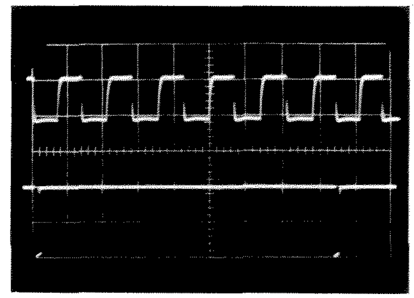
C. LOCKED OSC (TP2)
Sweep Rate: 2000 usec/cm
Amplitude: 20 volts/cm



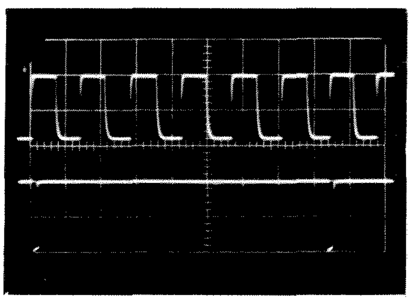
D. MOD OUT (TP6)
Sweep Rate: 2000 usec/cm
Amplitude: 0.5 volt/cm



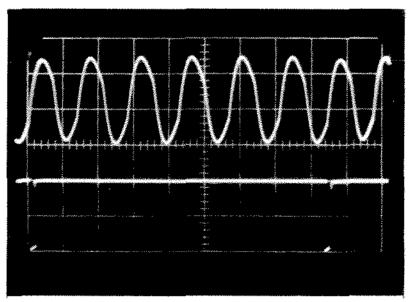
E. MOTOR DRIVE
Sweep Rate: 20000 usec/cm
Amplitude: 0.5 volt/cm



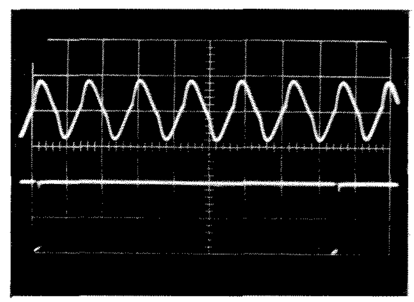
F. V14 Plate (pin 1)
Sweep Rate: 2000 usec/cm
Amplitude: 0.5 volt/cm



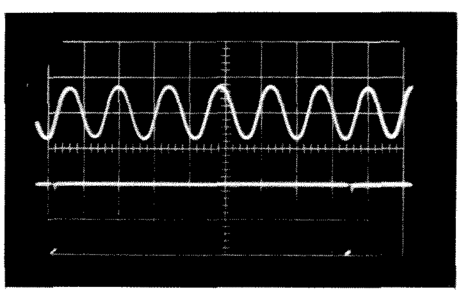
G. V14 Plate (pin 6)
Sweep Rate: 2000 usec/cm
Amplitude: 2 volts/cm



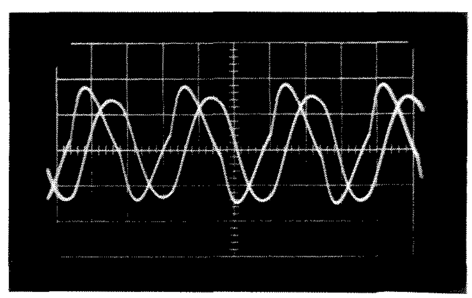
H. V15 Cathode (pin 3)
Sweep Rate: 2000 usec/cm
Amplitude: 1.0 volt/cm



I. PH 1 AMP (TP10)
Sweep Rate: 2000 usec/cm
Amplitude: 1.0 volt/cm

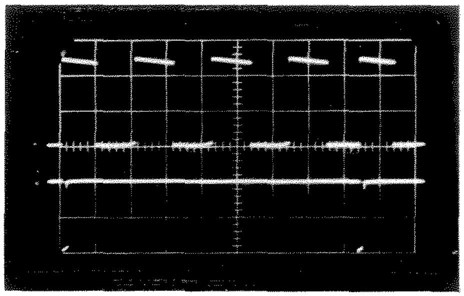


J. PH 2 AMP (TP11)
Sweep Rate: 2000 usec/cm
Amplitude: 1.0 volt/cm

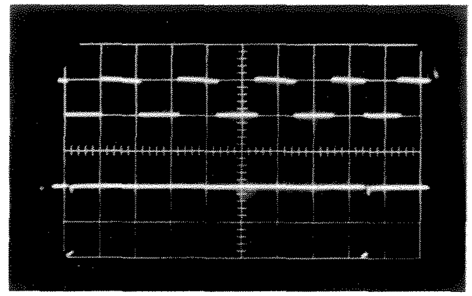


K. TP10 and TP11
Sweep Rate: 2000 usec/cm
Amplitude: 0.5 volt/cm

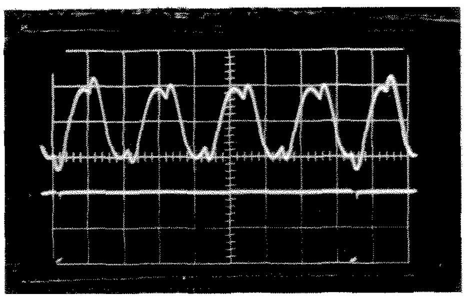
Figure HWS-13. Typical Waveforms
(Dual Trace—60-cycle Reference Pulse at Bottom, Amplitude 20 volts/cm)



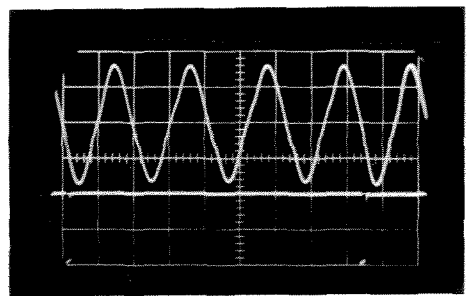
A. LOCKED OSC (TP2)
Sweep Rate: 2000 usec/cm
Amplitude: 20 volts/cm



B. MOTOR DRIVE (TP7)
Sweep Rate: 2000 usec/cm
Amplitude: 0.5 volt/cm



C. PH 1 AMP (TP10)
Sweep Rate: 2000 usec/cm
Amplitude: 1.0 volt/cm



D. PH 2 AMP
Sweep Rate: 2000 usec/cm
Amplitude: 1.0 volt/cm

Figure HWS-14. Typical Waveforms (SERVO-SYNC Switch in SERVO)

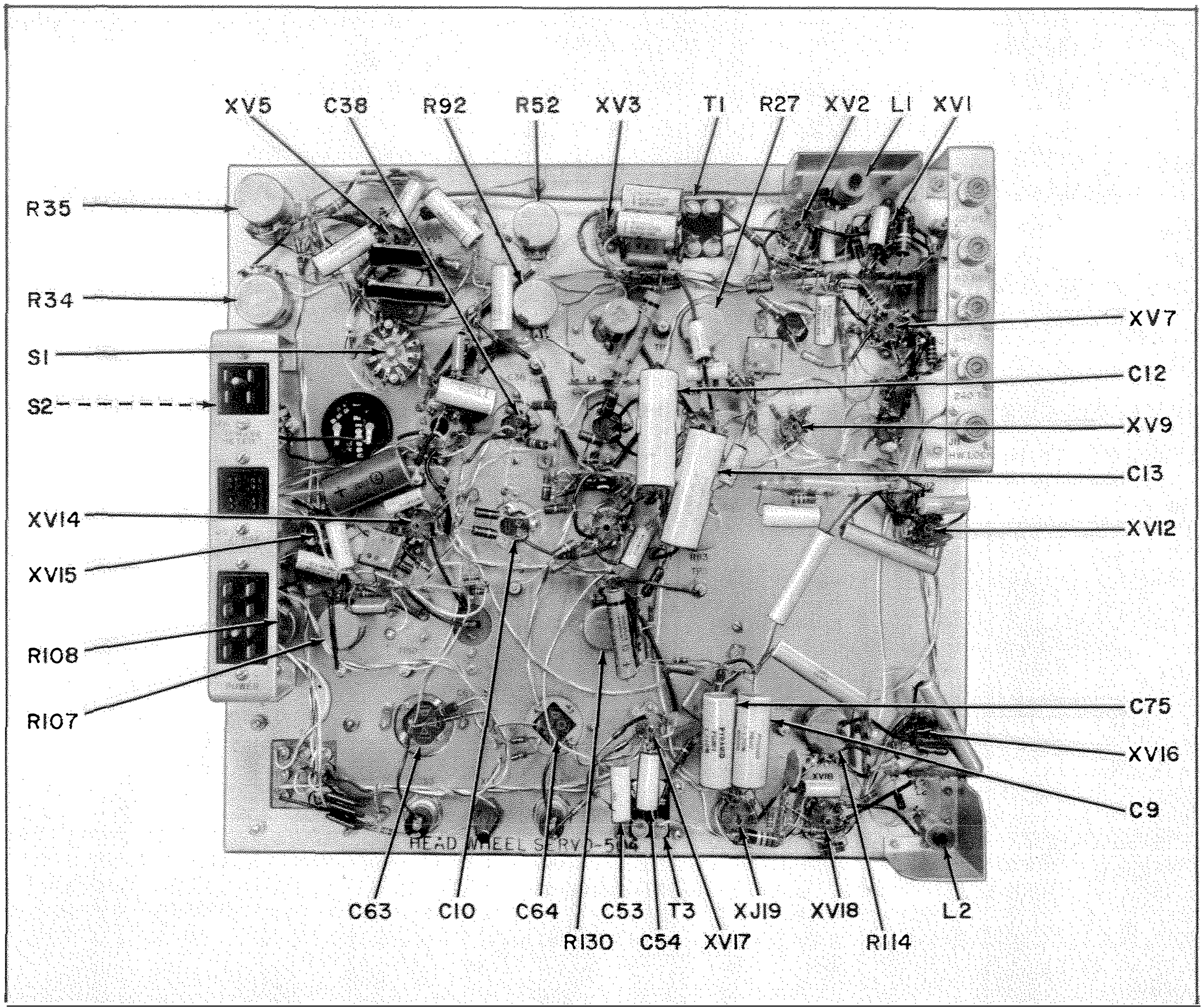


Figure HWS-15. Headwheel Servo (Rear View)

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			HEADWHEEL SERVO (#8974478-502) 14
			CAPACITORS:
C1		990786-275	plastic, 0.1 μf ±10%, 200 v
C2	203046	8958264-24	electrolytic, 10 μf 25 v
C3		990786-371	plastic, 0.047 μf ±10%, 400 v
C4A	32342	458557-14	electrolytic, 10/10 μf 450 v
C4B			Not Used
C5		990786-371	plastic, 0.047 μf ±10%, 400 v
C6, C7		990786-283	plastic, 0.47 μf ±10%, 200 v
C8		727866-263	mica, 4700 $\mu\mu$f ±5%, 500 v char "B"
C9	211741	737816-57	paper, 1.0 μf ±10%, 200 v
C10A, C10B	32342	458557-14	electrolytic, 10/10 μf 450 v
C11		8976580-2	ceramic, 0.05 μf -20 +80%, 500 v
C12, C13	221704	990429-177	paper, 0.47 μf ±10%, 600 v
C14		727866-155	mica, 2200 $\mu\mu$f ±10%, 500 v char "B"
C15		990786-379	plastic, 0.22 μf ±10%, 400 v
C16, C17		990786-375	plastic, 0.1 μf ±10%, 400 v
C18	221714	993026-900	mica, 43,000 $\mu\mu$f ±1%, 500 v
C19	221713	993026-892	mica, 20,000 $\mu\mu$f ±1%, 500 v

Symbol No.	Stock No.	Drawing No.	Description
C20			Not Used
C21, C22		990786-379	plastic, 0.22 μf ±10%, 400 v
C23		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C24		990786-275	plastic, 0.1 μf ±10%, 200 v
C25		727853-216	mica, 51 μμf ±5%, 500 v char "D"
C26		727851-123	mica, 100 μμf ±10%, 500 v char "B"
C27	219660	8924416-110	mica, 1000 μμf ±1%, 500 v
C28		990786-375	plastic, 0.1 μf ±10%, 400 v
C29A	32342	458557-14	electrolytic, 10/10 μf 450 v
C29B			Not Used
C30		727866-163	mica, 4700 μμf ±10%, 500 v char "B"
C31		990786-275	plastic, 0.1 μf ±10%, 200 v
C32A/B	32342	458557-14	electrolytic, 10/10 μf 450 v
C33		990786-275	plastic, 0.1 μf ±10%, 200 v
C34		8976580-2	ceramic, 0.05 μf -20 +80%, 500 v
C35 to C37			Not Used
C38A	99295	458557-5	electrolytic, 20/20 μf 450 v
C38B			Not Used
C39, C40		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C41		990786-371	plastic, 0.047 μf ±10%, 400 v
C42	99133	472938-1	electrolytic, 10 μf 450 v
C43			Not Used
C44		727866-269	mica, 8200 μμf ±5%, 300 v char "B"
C45		990786-375	plastic, 0.1 μf ±10%, 400 v
C46		727866-271	mica, 10,000 μμf ±5%, 300 v char "B"
C47, C48			Not Used
C49		8976580-2	ceramic, 0.05 μf -20 +80%, 500 v
C50	219661	8924416-119	mica, 2700 μμf ±1%, 500 v
C51A/B	32342	458557-14	electrolytic, 10/10 μf 450 v
C52		990786-371	plastic, 0.047 μf ±10%, 400 v
C53, C54		990786-279	plastic, 0.22 μf ±10%, 200 v
C55		727866-163	mica, 4700 μμf ±10%, 500 v char "B"
C56		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C57 to C62	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C63, C64	95914	458558-1	electrolytic, 125 μf -10 +50%, 350 v
C65			Not Used
C66		727866-271	mica, 10,000 μμf ±5%, 300 v char "B"
C67, C68	78145	8958264-46	electrolytic, 10 μf 150 v
C69		990786-283	plastic, 0.47 μf ±10%, 200 v
C70		727866-271	mica, 10,000 μμf ±5%, 300 v char "B"
C71	91391	442901-74	electrolytic, 10 μf 450 v
C72, C73		990786-275	plastic, 0.1 μf ±10%, 200 v
C74			Not Used
C75	211741	737816-57	paper, 1.0 μf ±10%, 200 v
C76		990786-283	plastic, 0.47 μf ±10%, 200 v
C77		990786-375	plastic, 0.1 μf ±10%, 400 v
C78		8924416-314	mica, 1500 μμf ±5%, 500 v char "F"
C79		8914319-322	mica, 82 μμf ±5%, 500 v char "F"
C80			Not Used
C81, 82		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C83		727866-155	mica, 2200 μμf ±10%, 500 v char "B"
CR1			Not Used
CR2	219245		Diode: type 1N2071
CR3	221128		Diode: type 1N456
CR4	219245		Diode: type 1N2071
CR5			Not Used
CR6 to CR10	221128		Diode: type 1N456
CR11	214105		Diode: type 1N458
CR12	221128		Diode: type 1N456
DS1			Not Used
DS2, DS3	101857	872291-9	Lamp: indicating NE51
F1	218628	990157-107	Fuse: 3/4 A 250 v slo-blo
J1 to J4	51800	255223-2	Connector: coax
J5	99165	727969-26	Connector: female, 4 contacts
J6	52107	727969-13	Connector: male, 4 contacts
J7	55806	727969-7	Connector: male, 8 contacts

Symbol No.	Stock No.	Drawing No.	Description
J8	51800	255223-2	Connector: coax
K1	206744	460355-2	Relay: 24 v D.C. D.P.D.T.
L1, L2	222947	8980021-1	Coil: variable, 15/60 MH
L3	221715	8513600-10	Coil
M1	218633	8980017-1	Meter: 0-100 v, AC
P1			Connector: coax, cable mtg.
	66344	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P2	66344	252868-1	Connector: coax, cable mtg.
P3			Connector: coax, cable mtg.
	66344	252868-1	Connector - only
	54246	893648-2	Adapter - solder type
P4	66344	252868-1	Connector: coax, cable mtg.
P5	99213	727969-27	Connector: male, 4 contact
P6	52108	727969-14	Connector: female, 4 contacts
P7	55808	727969-8	Connector: female, 8 contacts
P8	66344	252868-1	Connector: coax, cable mtg.
			RESISTOR:
			Fixed, Composition - unless otherwise specified
R1		82283-239	2.2 meg ±5%, ½ w
R2		99126-78	22,000 ohms ±10%, 2 w
R3		82283-54	220 ohms, ±10%, ½ w
R4		82283-207	100,000 ohms, ±5%, ½ w
R5		82283-173	3900 ohms ±5%, ½ w
R6		82283-94	470,000 ohms, ±10%, ½ w
R7		82283-86	100,000 ohms, ±10%, ½ w
R8		82283-153	560 ohms, ±5%, ½ w
R9		82283-98	1 meg ±10%, ½ w
R10		99126-189	18,000 ohms ±5%, 2 w
R11		82283-195	33,000 ohms, ±5%, ½ w
R12			Not Used
R13		82283-223	470,000 ohms, ±5%, ½ w
R14		82283-207	100,000 ohms, ±5%, ½ w
R15		82283-86	100,000 ohms, ±10%, ½ w
R16, R17		90496-60	680 ohms, ±10%, 1 w
R18, R19	215169	8835333-109	1000 ohms, ±1%, ½ w , film
R20, R21			Not Used
R22		82283-50	100 ohms, ±10%, ½ w
R23, R24		90496-60	680 ohms, ±10%, 1 w
R25		90496-209	120,000 ohms, ±5%, 1 w
R26		82283-231	1 meg ±5%, ½ w
R27	212133	8971860-120	variable, 2.5 meg ±20%, 2 w
R28		82283-207	100,000 ohms, ±5%, ½ w
R29, R30		82283-187	15,000 ohms, ±5%, ½ w
R31		82283-209	120,000 ohms, ±5%, ½ w
R32		82283-201	56,000 ohms, ±5%, ½ w
R33		90496-209	120,000 ohms, ±5%, 1 w
R34, R35	221706	737881-3	variable, 2000/2000 ohms, ±20%, 2 w
R36, R37	211785	990188-409	film, 12,100 ohms, ±1%, 1 w
R38		90496-60	680 ohms, ±10%, 1 w
R39		82283-207	100,000 ohms, ±5%, ½ w
R40		90496-88	150,000 ohms, ±10%, 1 w
R41, R42		82283-225	560,000 ohms, ±5%, ½ w
R43, R44	222580	990733-451	33,200 ohms, ±1%, 1 w
R45		82283-199	47,000 ohms, ±5%, ½ w
R46		82283-201	56,000 ohms, ±5%, ½ w
R47		82283-187	15,000 ohms, ±5%, ½ w
R48		82283-207	100,000 ohms, ±5%, ½ w
R49 to R56			Not Used
R57	93469	8835333-140	film, 8200 ohms, ±1%, ½ w
R58	207410	990185-561	0.422 meg ±1%, ½ w
R59		90496-80	33,000 ohms, ±10%, 1 w
R60		82283-86	100,000 ohms, ±10%, ½ w
R61		90496-183	10,000 ohms, ±5%. 1 w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R62	219729	8945608-199	film, 3.16 meg, ±1%, 1 w
R63			Not Used
R64, R65	219728	8945608-198	film, 33,200 ohms, ±1%, 2 w
R66		82283-99	1.2 meg ±10%, ½ w
R67		82283-95	560,000 ohms, ±10%, ½ w
R68		90496-195	33,000 ohms, ±5%, 1 w
R69, R70		90496-60	680 ohms, ±10%, 1 w
R71		82283-171	3300 ohms, ±5%, ½ w
R72		82283-219	330,000 ohms, ±5%, ½ w
R73	216376	990733-518	film, 150,000 ohms, ±1%, 1 w
R74		82283-221	390,000 ohms, ±5%, ½ w
R75		82283-171	3300 ohms, ±5%, ½ w
R76, R77		90496-60	680 ohms, ±10%, 1 w
R78			Not Used
R79, R80		82283-50	100 ohms, ±10%, ½ w
R81, R82		90496-60	680 ohms, ±10%, 1 w
R83	212133	8971860-120	2.5 meg ±20%, 2 w variable
R84 to R91			Not Used
R92	98077	8971860-113	variable, 50,000 ohms, ±10%, 2 w
R93		82283-98	1 meg ±10%, ½ w
R94		82283-86	100,000 ohms, ±10%, ½ w
R95		82283-159	1000 ohms, ±5%, ½ w
R96		90496-183	10,000 ohms, ±5%, 1 w
R97		82283-98	1 meg ±10%, ½ w
R98		90496-74	10,000 ohms, ±10%, 1 w
R99		82283-86	100,000 ohms, ±10%, ½ w
R100		82283-239	2.2 meg ±5%, ½ w
R101		82283-159	1000 ohms, ±5%, ½ w
R102		82283-225	560,000 ohms, ±5%, ½ w
R103		90496-75	12,000 ohms, ±10%, 1 w
R104		82283-199	47,000 ohms, ±5%, ½ w
R105			Not Used
R106		82283-185	12,000 ohms, ±5%, ½ w
R107, R108	97961	8971860-117	variable, 500,000 ohms, ±10%, 2 w
R109			Not Used
R110, R111		90496-60	680 ohms, ±10%, 1 w
R112		99126-79	27,000 ohms, ±10%, 2 w
R113	221703	8945608-201	film, 1.10 meg ±1%, ½ w
R114	57402	8971860-116	variable, 250,000 ohms, ±10%, 2 w
R115		82283-86	100,000 ohms, ±10%, ½ w
R116	219728	8945608-198	film, 33,200 ohms, ±1%, 2 w
R117		90496-183	10,000 ohms, ±5%, 1 w
R118	219728	8945608-198	film, 33,200 ohms, ±1%, 2 w
R119		82283-171	3300 ohms, ±5%, ½ w
R120		90496-62	1000 ohms, ±10%, 1 w
R121		82283-223	470,000 ohms, ±5%, ½ w
R122		82283-207	100,000 ohms, ±5%, ½ w
R123		82283-183	10,000 ohms, ±5%, ½ w
R124, R125		90496-60	680 ohms, ±10%, 1 w
R126, R127	215169	8835333-109	film, 1000 ohms, ±1%, ½ w
R128, R129		82283-231	1 meg ±5%, ½ w
R130	93175	8971860-110	variable, 10,000 ohms, ±10%, 2 w
R131	206018	990730-566	film, 475,000 ohms, ±1%, ½ w
R132		82283-221	390,000 ohms, ±5%, ½ w
R133, R134		90496-60	680 ohms, ±10%, 1 w
R135			Not Used
R136		82283-191	22,000 ohms, ±5%, ½ w
R137		90496-209	120,000 ohms, ±5%, 1 w
R138		82283-201	56,000 ohms, ±5%, ½ w
R139		90496-203	68,000 ohms, ±5%, 1 w
R140		82283-191	22,000 ohms, ±5%, ½ w
R141		82283-201	56,000 ohms, ±5%, ½ w
R142, R143		82283-111	10 ohms, ±5%, ½ w
R144			Pt. of XDS2
R145		82283-87	120,000 ohms, ±10%, ½ w

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
R146			Pt. of XDS3
R147		82283-94	470,000 ohms, ±10%, ½ w
R148		82283-171	3300 ohms, ±5%, ½ w
R149		82283-67	2700 ohms, ±10%, ½ w
R150, R151			Not Used
R152	205044	8971860-114	variable, 100,000 ohms, ±10%, 2 w
R153		82283-67	2700 ohms, ±10%, ½ w
R154, to R157			Not Used
R158		82283-214	200,000 ohms, ±5%, ½ w
R159		82283-159	1000 ohms, ±5%, ½ w
R160, R161		722362-199	47,000 ohms, ±5%, 2 w
R162, R163		82283-171	3300 ohms, ±5%, ½ w
R164, R165			Not Used
R166, R167		82283-183	10,000 ohms, ±5%, ½ w
R168			Not Used
R169, R170		82283-175	4700 ohms, ±5%, ½ w
R171	221130	990730-538	film, 243,000 ohms, ±1%, ½ w
R172		82283-201	56,000 ohms, ±5%, ½ w
R173			Not Used
R174		82283-50	100 ohms, ±10%, ½ w
R175		90496-186	13,000 ohms, ±5%, 1 w
R176		82283-167	2200 ohms, ±5%, ½ w
R177		82283-199	47,000 ohms, ±5%, ½ w
R178		82283-240	2.4 meg ±5%, ½ w
R179, R180		82283-159	1000 ohms, ±5%, ½ w
S1	221705	8462423-1	Switch: rotary
S2	218632	8441361-1	Switch: rotary
T1	51936	895314-1	Transformer: pulse
T2			Not Used
T3	51936	895314-1	Transformer: pulse
T4	94713	443975-3	Transformer: filament
TP1 to TP12	208983	8825493-7	Jack: tip, yellow
XADS1			Not Used
XADS2, XADS3	208080	990788-507	Jewel: indicating lamp
XDS1			Not Used
XDS2, XDS3	208458	990789-5	Socket: indicating lamp
XF1	48894	99088-2	Holder: fuse
XK1	68590	99100-4	Socket: relay
XV1, XV2	94926	737870-14	Socket: tube, 9 pin miniature
XV3	94925	737867-14	Socket: tube, 7 pin miniature
XV4			Not Used
XV5	94926	737870-14	Socket: tube, 9 pin miniature
XV6			Not Used
XV7	94926	737870-14	Socket: tube, 9 pin miniature
XV8, XV9	94925	737867-14	Socket: tube, 7 pin miniature
XV10	94926	737870-14	Socket: tube, 9 pin miniature
XV11			Not Used
XV12 to XV16	94926	737870-14	Socket: tube, 9 pin miniature
XV17	94925	737867-14	Socket: tube, 7 pin miniature
XV18, XV19	94926	737870-14	Socket: tube, 9 pin miniature
			Miscellaneous:
	30075	712336-507	Knob: black
	99244	8849946-1	Knob: red

VOLTAGE TABLE

Symbol	Type	Pin Numbers								
		1	2	3	4	5	6	7	8	9
V1	12AT7	190	12	14	6.3 ac	6.3 ac	.3	−141	−140	6.3 ac
V2	12BH7	270	.3	15	6.3 ac	6.3 ac	275	−25	0	6.3 ac
V3	6AL5	3	3	6.3 ac	6.3 ac	5.8	NC	−11	—	—
V5	6201	215	−48	−7	6.3 ac	6.3 ac	215	−47	−5.2	6.3 ac
V7	12AT7	205	−3	0	6.3 ac	6.3 ac	270	−46	4.5	6.3 ac
V8	6AL5	275	200	6.3 ac	6.3 ac	270	NC	210	—	—
V9	6AL5	4.5	−8	6.3 ac	6.3 ac	−8	NC	−8	—	—
V10	12AU7	270	14	35	6.3 ac	6.3 ac	270	11	39	6.3 ac
V12	6201	−30	−170	−145	6.3 ac	6.3 ac	200	−30	.32	6.3 ac
V13	5751	275	−3	−.1	6.3 ac	6.3 ac	275	−1	1.7	6.3 ac
V14	12AX7	150	0	1	6.3 ac	6.3 ac	150	0	1	6.3 ac
V15	12AU7	270	54	64	6.3 ac	6.3 ac	NC	NC	NC	6.3 ac
V16	6201	−36	−175	−150	6.3 ac	6.3 ac	200	−36	−6	6.3 ac
V17	6AL5	−1.8	−1.8	6.3 ac	6.3 ac	21	NC	−20	—	—
V18	12BH7	265	−6.5	6.7	6.3 ac	6.3 ac	275	−27	0	6.3 ac
V19	6201	260	.2	3.7	6.3 ac	6.3 ac	NC	NC	NC	6.3 ac

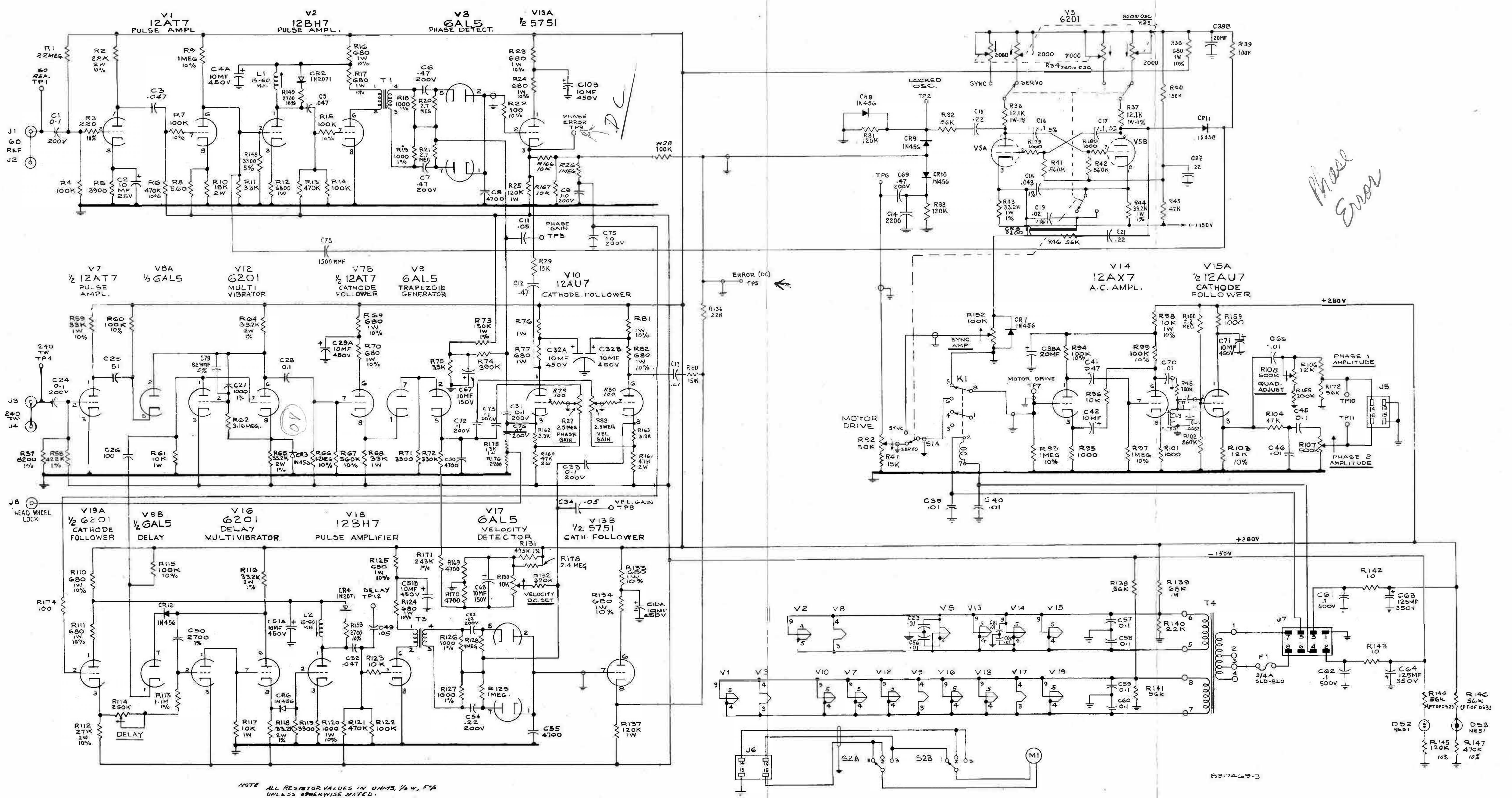


Figure HWS-16. Headwheel Servo Schematic Diagram

Tonewheel Amplifier

UNIT 505

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WB 671

IB-31152

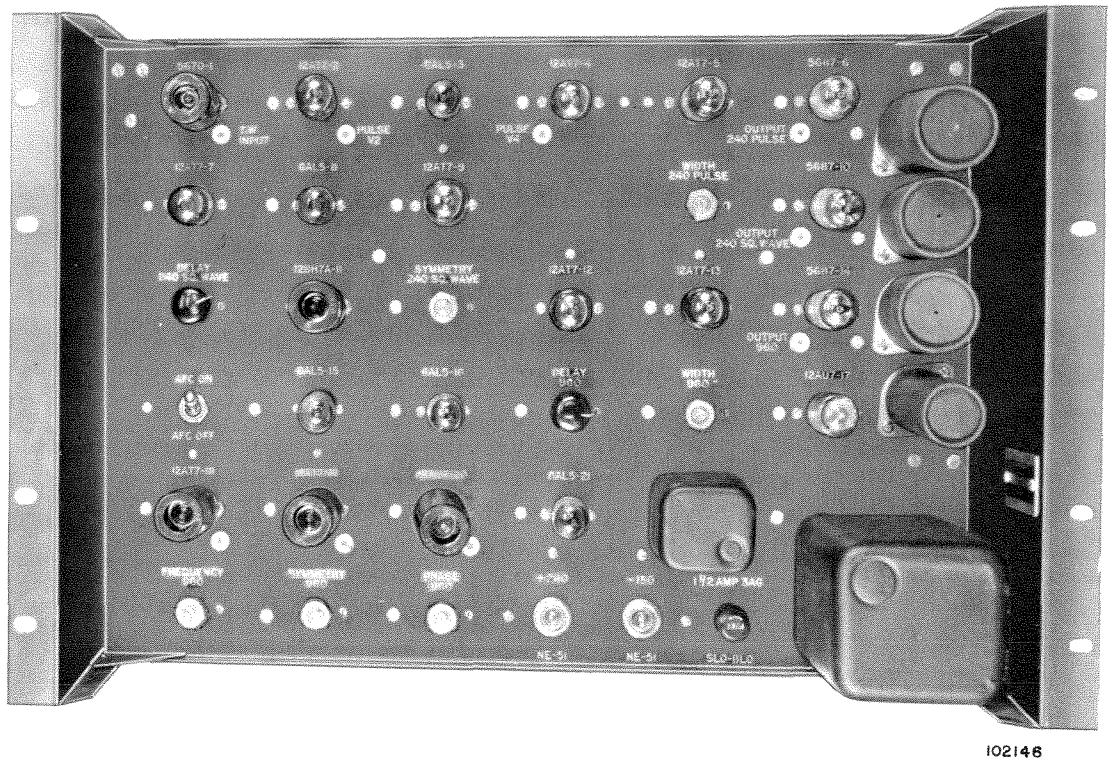


Figure TWA-1. Tonewheel Amplifier, Front View

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cps, 55 watts
(from circuit breaker No. 5)

DC: 280 volts, 120 ma
(from power supply No. 2, unit 410)
—150 volts, 100 ma
(from —150 volt power supply, unit 405)

Input

240 cycle pulse:
1.5 to 1.8 volts p-p (from tonewheel head)

Outputs

240 cycle pulse:
4 volts p-p, nominal (to headwheel servo, unit 504)

Delayed 240 cycle square-wave:
4 volts p-p, nominal (to capstan servo, unit 404)

960 cycle pulse:
4 volts p-p, nominal (to guide servo, unit 506)

Output Impedances

75 ohms

Fuse

1½ amperes, slo-blo, 3AG

Tube and Diode Complement

Tubes:

1—5670
9—12AT7
5—6AL5
1—12BH7A
2—12AU7
3—5687

Diodes:

9—1N34A

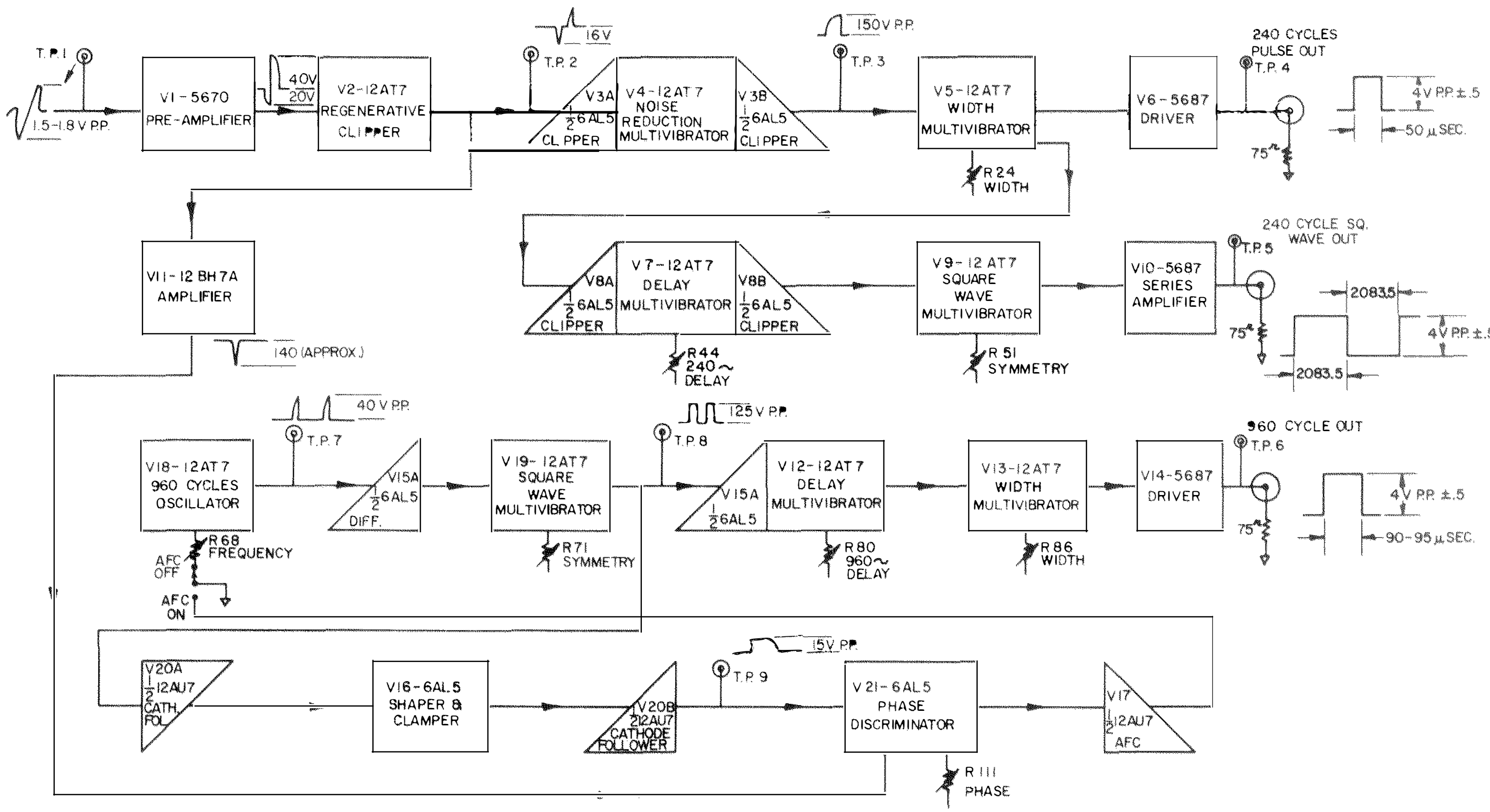


Figure TWA-2. Block Diagram of Tonewheel Amplifier

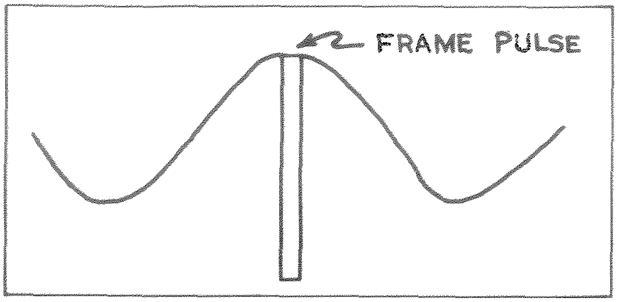


Figure TWA-3. Position of Frame Pulse in Relation to Control Track Signal

DESCRIPTION

Figure TWA-1 shows a front view of the Tonewheel Amplifier (unit 505). The three basic functions of the unit are:

1. To amplify and shape the 240-cycle input pulse from the tonewheel head into a 240-cycle rectangular pulse of 50 microseconds width. (Refer to block diagram, figure TWA-2.)

2. To provide the above 50 microsecond pulse with an adjustable delay, and convert it into a 240-cycle square wave.

3. To generate a 960-cycle pulse which, through the utilization of an afc circuit, is "locked" to the incoming 240-cycle tonewheel pulse. The 960-cycle pulse is also provided with an adjustable delay.

The 240-cycle 50 microsecond rectangular pulse output is applied as a trigger pulse to the 4 x 2 switcher (unit 207) and 2 x 1 switcher (unit 309). The pulse is also applied to the headwheel servo (unit 504) where it is compared with pulses derived from a stable reference source to maintain a constant headwheel velocity.

The 240-cycle square wave output is fed to the capstan servo (unit 404) where it is converted into a 240-cycle sine wave and applied to the control track head during the record mode of operation. The delay available is variable from 350 to 2500 microseconds so that it is possible to adjust the position of the 240-cycle sine wave on the control track relative to the frame pulse (figure TWA-3). During playback the speed of the capstan motor, and hence the tape speed, is controlled by comparing the 240-cycle sine wave signal from the control track with the 240-cycle tonewheel 50 microsecond pulse.

The 960-cycle pulse output is applied to the guide servo (unit 506) and 2 X 1 switcher. An adjustable delay of 450 to 850 microseconds is provided to compensate for possible errors in quadrature between the tonewheel head and video head number 1.

Circuits

240-Cycle Pulse. The 240-cycle tonewheel head pulse (figure TWA-4), having an amplitude of 1.5 to 1.8 volts peak-to-peak, is fed into a preamplifier consisting of two cascaded triodes (V1) which increase the pulse amplitude to approximately 60 volts peak-to-peak. (Refer to block diagram, figure TWA-2, and schematic diagram, figure TWA-23.) Regenerative clipper V2 converts the amplified tonewheel pulse into a rectangular pulse having an amplitude of approximately 42 volts. The rectangular pulse is differentiated before being fed simultaneously to diode V3A and amplifier V11.

The leading edge of the negative-going differentiated pulse triggers multivibrators V4 and V5. Triggering V4, the noise reduction multivibrator, shifts the biases on diodes V3A and V3B cutting them off and thereby disconnecting multivibrator V5 from the input. The time-constant of multivibrator V4 keeps the diodes cut off for a period slightly less than the 240-cycle pulse period. This prevents extraneous pulses or noise from reaching V5, thereby allowing only those pulses which arrive near the normal triggering time to produce an output pulse. Potentiometer R24 (WIDTH 240 PULSE) varies the bias voltage applied to the left-hand section of V5 so that the pulse width may be adjusted to exactly 50 microseconds (see *Maintenance*).

The 240-cycle 50 microsecond pulse is fed from the cathode of the right-hand section of V5 to cathode follower V6 which drives the output 75-ohm line. The pulse output, having an amplitude of approximately 4 volts, may be observed at test point TP4 (OUTPUT 240 PULSE) and is shown in figure TWA-5 (top).

240-Cycle Square Wave. The 240-cycle pulse output from V7 is differentiated, and the positive-going spike is clipped by diode V8B while the delayed negative-going spike is fed to square wave multivibrator V9. The trailing edge of the delayed negative-going pulse triggers V9 producing a 240-cycle square wave having an amplitude of approximately 150 volts peak-to-peak.

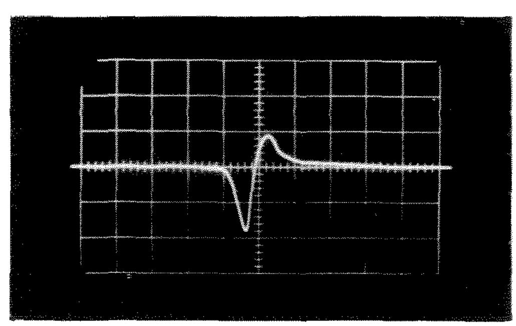
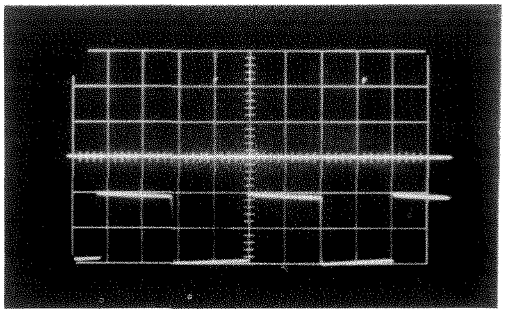
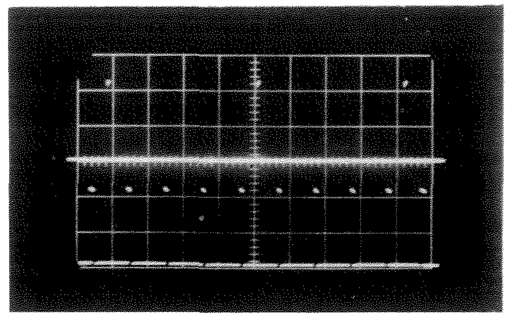


Figure TWA-4. 240-Cycle Tonewheel Head Pulse at TP1



Top: 240-Cycle Pulse Output at TP4
Bottom: 240-Cycle Square Wave Output at TP5

Figure TWA-5.



Top: 240-Cycle Pulse Output at TP4
Bottom: 960-Cycle Pulse Output at TP6

Figure TWA-6.

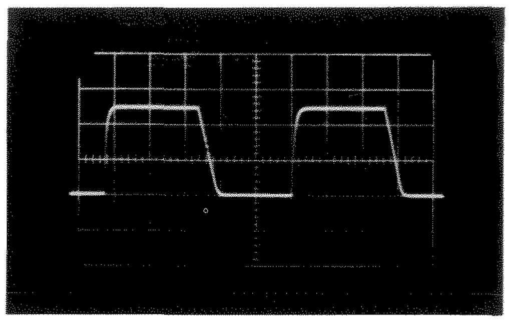


Figure TWA-7. 240-Cycle Pulse Positioned on Slope of Trapezoidal Wave (TP9)

Potentiometer R51 (SYMMETRY 240 SQ. WAVE) varies the grid bias voltage of the left-hand section of V9 so that a symmetrical square wave may be obtained (see *Maintenance*).

The 240-cycle square wave output from V9 is fed to series amplifier V10, which drives a 75-ohm line. Figure TWA-5 (bottom) shows the 240-cycle square wave output as it appears at test point TP5 (OUTPUT 240 SQ. WAVE) and output jack J3.

960-Cycle Pulse. The 960-cycle pulse is generated internally by means of a free-running oscillator (V18). The frequency of the oscillator is compared with the frequency of the tonewheel pulse by an afc loop, and any error signal derived is utilized to control the oscillator frequency. Potentiometer R68 (FREQUENCY 960) is provided in the oscillator circuit so that the 960-cycle frequency may be set initially (see *Maintenance*). Test point TP7 (FREQUENCY 960) is provided as a convenient point to observe the 960-cycle pulse, using a low capacity oscilloscope probe.

The 960-cycle pulse output of V18, having an amplitude of approximately 40 volts, is differentiated, and the positive-going spike is clipped by diode V15A while the negative-going spike is fed to square wave multivibrator V19 as a triggering pulse. Multivibrator V19 produces a 960-cycle square wave which is fed simultaneously to cathode follower V20A and diode clipper V15B. Potentiometer R71 (SYMMETRY 960) varies the grid bias voltage of the left-hand section of V19 so that a symmetrical square wave output may be obtained (see *Maintenance*).

Diode V15B clips the positive-going spike from the 960-cycle differentiated square wave before it is fed to delay multivibrator V12 as a triggering pulse. The delay obtained by V12 may be varied from 450 to 850 microseconds, with respect to the 240-cycle tonewheel pulse, by potentiometer R80 (DELAY 960) in the grid circuit of the left-hand section of V12 (see *Maintenance*).

The output of delay multivibrator V12 triggers pulse width multivibrator V13 which produces a 960-cycle pulse having an amplitude of approximately 55 volts and a width which may be adjusted to 90-95 microseconds by potentiometer R86 (WIDTH 960) as described in the *Maintenance* section. The 960-cycle pulse output from V13 is fed to pulse driver stage V14 which operates as a cathode follower, driving the 75-ohm line. Figure TWA-6 (bottom) shows the 960-cycle output pulse, having an amplitude of approximately 4 volts and a width of 90 to 95 microseconds, as it appears at test point TP6 (OUTPUT 960) and output jack J4.

The afc loop, which provides an error signal to maintain a constant 960-cycle frequency, derives its information from the output of square wave multivibrator V19. The 960-cycle square wave is fed to shaper and clamper stage V16 which converts it into a trapezoidal wave. Cathode followers V20A and V20B provide isolation and impedance matching at either end of V16.

Phase discriminator V21 receives the trapezoidal wave from cathode follower V20B, and the differentiated 240-cycle tone wheel pulse which has been amplified by pulse amplifier V11 before being coupled to the discriminator circuit by transformer T2. Potentiometer R111 (PHASE 960) provides an adjustment of the phase relationship between the trapezoidal wave and the 240-cycle pulse so that the pulse may be positioned on the slope of the trapezoidal wave (figure TWA-7). (To adjust the PHASE 960 potentiometer, refer to the section on *Maintenance.*)

When the 960-cycle oscillator begins to drift off frequency it causes a change in the phase relationship between the 240-cycle pulse and 960-cycle trapezoidal wave which in turn causes the phase discriminator to produce a dc error signal. This error signal is fed from cathode follower V17 to the oscillator stage, correcting its frequency to remove the phase error. Switch S1 (AFC ON-AFC OFF) in the cathode circuit of V17 disables the afc circuit when in the OFF position (see *Maintenance*).

IMPORTANT: The AFC switch must be in the ON position during all tape recorder modes of operation.

MAINTENANCE

Video Head Switching Adjustment Following Replacement of Headwheel Panel

Replacement of the headwheel panel (unit 200A) may occasionally necessitate an adjustment of the video head switching point on the 2 X 1 switcher (unit 309). To determine whether or not this adjustment is necessary, place the machine in playback mode (tape threaded), press MONITOR LINE OUT pushbutton on CRO/MON switcher, and observe the picture monitor. If horizontal lines appear, the switching point must be adjusted. To make the adjustment, rotate DELAY 960 control on tonewheel amplifier until horizontal lines disappear and position the control in the center of the range during which no horizontal lines are present.

An alternate method of making the adjustment is by pressing OSCILLOSCOPE 2 X 1 OUT pushbutton on the CRO/MON switcher and observing waveform monitor while adjusting the DELAY 960 control so that the gaps between video head outputs are eliminated. (Refer to figure TWA-8.) Position control in center of range as noted above.

Tonewheel Amplifier Adjustments

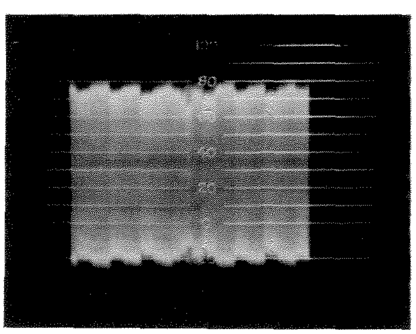
All tonewheel amplifier adjustments may be made from the front panel of the unit, utilizing a Tektronix Type 535 oscilloscope (or equivalent) having two low capacity attenuator probes (10:1, 11.5 uuf).

The adjustment procedures outlined below are made with a normal 1.5 to 1.8 volt peak-to-peak tonewheel head input pulse applied to the unit. The AFC switch must be ON and the machine in setup mode, unless otherwise noted. The oscilloscope should be triggered with the output of the REF test point on the reference generator (unit 407) test module. If the adjustments cannot be made as specified, refer to the *Trouble Shooting Chart.*

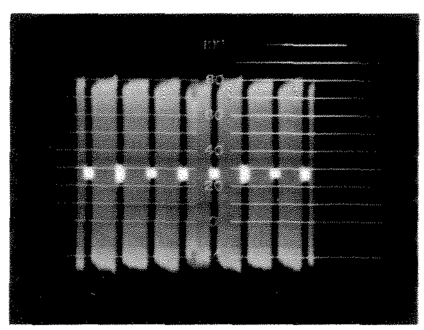
NOTE: The headwheel servo must be locked-in before the following adjustments are made.

240-Cycle Pulse Width.

1. Connect oscilloscope to OUTPUT 240 PULSE test point (TP4).

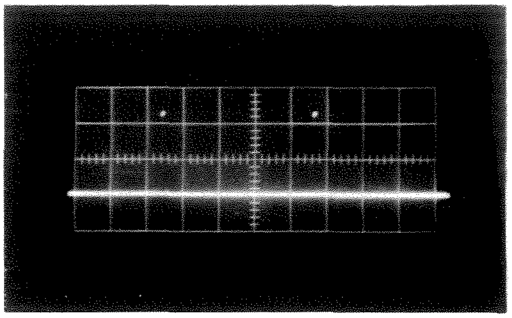


A. DELAY 960 Control Correctly Adjusted

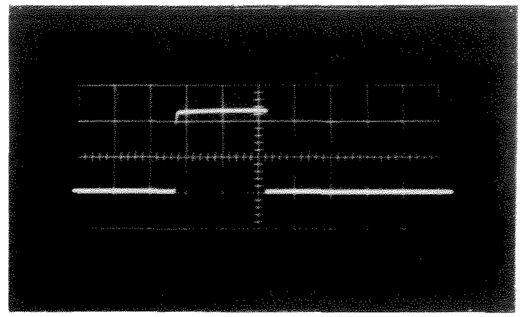


B. DELAY 960 Control Misadjusted

Figure TWA-8. 2 X 1 OUT on Waveform Monitor



A. 2v/div; 1000 usec/div



B. 2v/div; 20 usec/div

Figure TWA-9. 240-Cycle Pulse Output at TP4

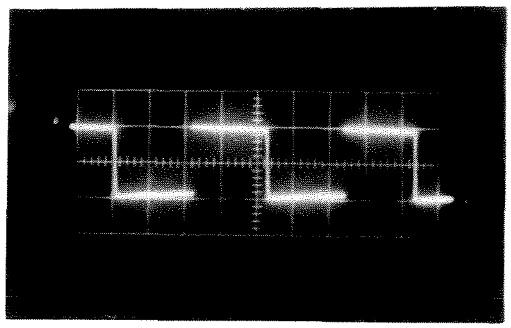


Figure TWA 10. 240-Cycle Square Wave at TP5 (2v/div; 1000 usec/div)

2. Adjust screwdriver control WIDTH 240 PULSE for 240-cycle pulse having a 50 microsecond width (figure TWA-9).

240-Cycle Square Wave Symmetry.

1. Connect oscilloscope probe to OUTPUT 240 SQ. WAVE test point (TP5).

2. Adjust screwdriver control SYMMETRY 240 SQ. WAVE for symmetrical 240-cycle square wave (figure TWA-10).

240-Cycle Square Wave Delay Range.

1. Connect oscilloscope input A probe to OUTPUT 240 PULSE test point (TP4) and input B probe to OUTPUT 240 SQ. WAVE test point (TP5).

2. Check DELAY 240 SQ. WAVE control for a 240-cycle square wave nominal delay range of 350 to 2500 microseconds with respect to the 240-cycle pulse (figure TWA-11).

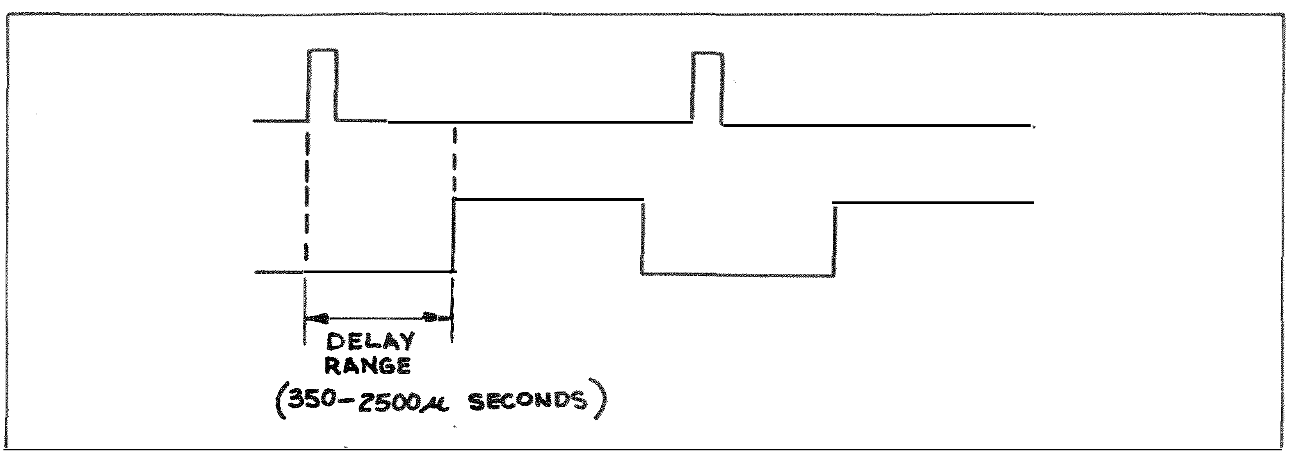


Figure TWA-11. Delay Range of 240-Cycle Square Wave (bottom) with Reference to 240-Cycle Pulse (top)

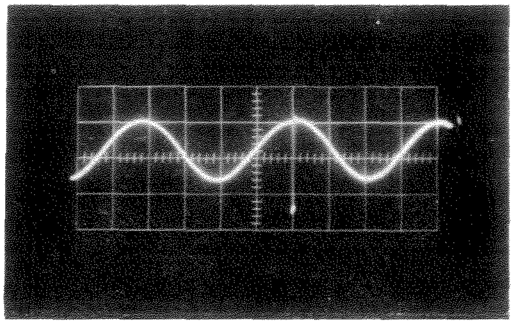
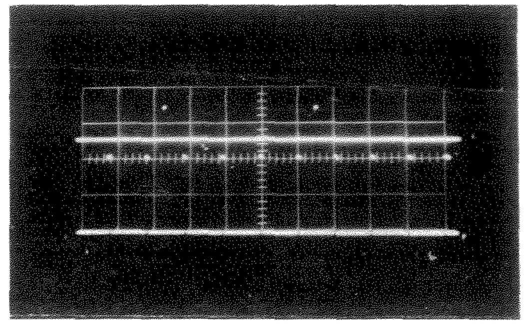


Figure TWA-12. MON CT REC (TP11) on Capstan Servo Chassis (0.5 v/div; 1000 usec/div)



Top: 240-Cycle Pulse Output at TP4 (2v/div; 1000 usec/div)
Bottom: 960-Cycle Pulse Output at TP6 (5v/div; 1000 usec/div)

Figure TWA-13.

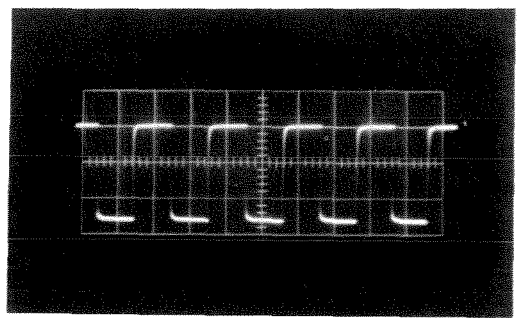


Figure TWA-14. 960-Cycle Square Wave at TP8 (50v/div; 500 usec/div)

240-Cycle Square Wave Delay.

1. Connect oscilloscope probe to MON CT REC test point on capstan servo chassis, unit 404 (or press CT REC pushbutton on CRO/MON switcher and observe waveform on waveform monitor).

2. Adjust DELAY 240 SQ. WAVE control to center frame pulse in the positive half of the sine wave (figure TWA-12).

960-Cycle Oscillator Frequency.

1. Connect oscilloscope input A probe to OUTPUT 240 PULSE test point (TP4) and input B probe to OUTPUT 960 test point (TP6).

2. Turn AFC switch off and adjust FREQUENCY 960 screwdriver control to obtain 4:1 pattern on scope as shown in figure TWA-13. (The 960-cycle pulse will not remain locked on the 240-cycle pulse; however, the drift should be at a very slow rate. It should also be noted that the time interval between two consecutive 960-cycle pulses is approximately 1042 microseconds.)

3. Return the AFC switch to ON position.

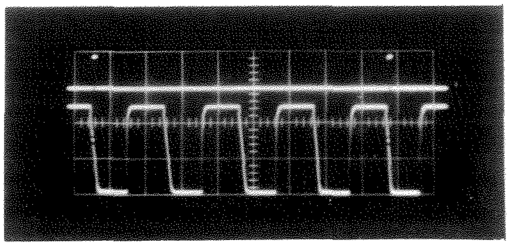
960-Cycle Pulse Symmetry.

1. Connect oscilloscope probe to SYMMETRY 960 test point (TP8).

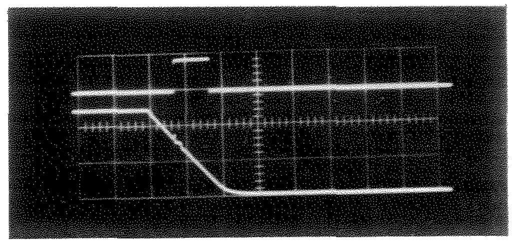
2. Adjust SYMMETRY 960 screwdriver control to obtain a symmetrical 960-cycle square wave (figure TWA-14).

960-Cycle Phase.

1. Connect oscilloscope input A probe to OUTPUT 240 PULSE test point (TP4) and input B probe to PHASE 960 test point (TP9).



A. Top: 240-Cycle Pulse Output at TP4
Bottom: PHASE 960 at TP9
(5v/div; 500 usec/div)



B. Same as A Except Horizontal Sweep Rate is 50 usec/div

Figure TWA-15. 240-Cycle Pip on Slope of Every Fourth Trapezoidal Wave

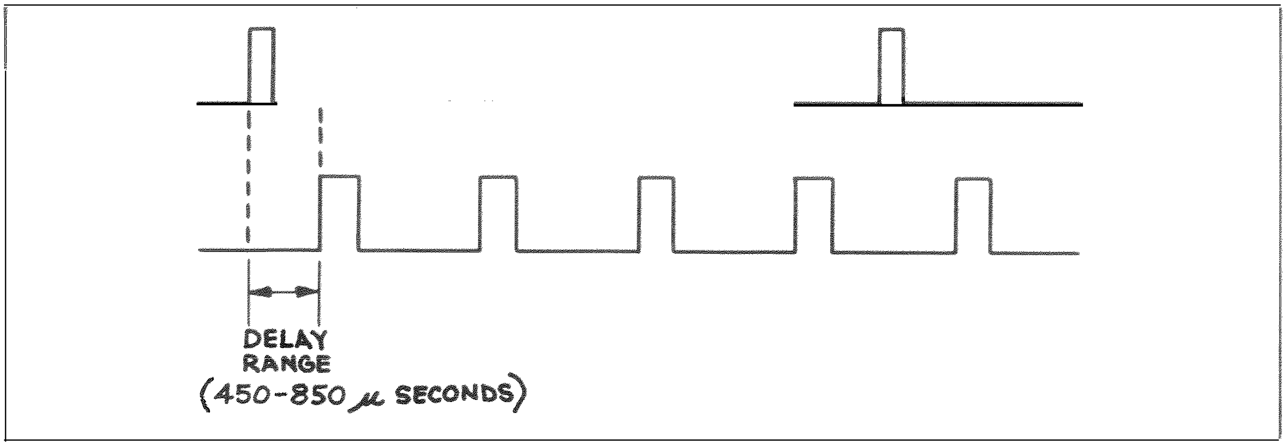


Figure TWA-16. Delay Range of 960-Cycle Pulse (bottom) with Reference to 240-Cycle Pulse (top)

2. Adjust PHASE 960 screwdriver control so that the 240-cycle pip is locked 45% down on the slope of every fourth trapezoid (figure TWA-15).

3. Turn AFC switch off and on several times to ascertain that locking between the two frequencies occurs instantaneously and consistently.

960-Cycle Pulse Delay Range. The 960-cycle pulse delay adjustment procedures have been outlined previously under *Video Head Switching Adjustment Following Replacement of Head Wheel Panel.* To check the 960-cycle pulse delay range, proceed as follows:

1. Connect oscilloscope input A probe to OUTPUT 240 PULSE test point (TP4) and input B probe to OUTPUT 960 test point (TP6).

2. Check DELAY 960 control for a 960-cycle pulse nominal delay range of 450 to 850 microseconds with respect to the 240-cycle pulse (figure TWA-16).

960-Cycle Pulse Width.

1. Connect oscilloscope probe to OUTPUT 960 test point (TP6).

2. Adjust WIDTH 960 screwdriver control to obtain a 960-cycle pulse width of 90 to 95 microseconds (figure TWA-17).

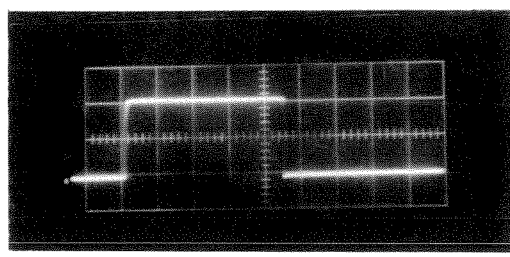


Figure TWA-17. 960-Cycle Pulse Output at TP6 (1v/div; 20 usec/div)

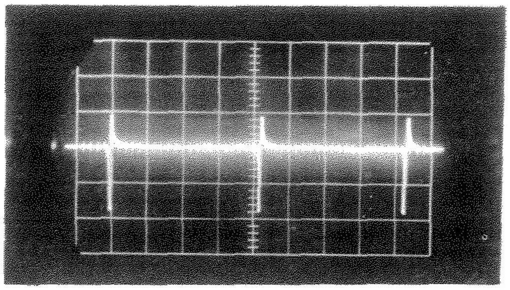
Trouble Shooting

The *Trouble Shooting Chart* indicates symptoms of possible troubles in the unit and corrective action to be taken if the troubles occur. If defective tubes or components are found while making circuit checks, replace with exact types and ratings specified. When making the circuit checks, a 240-cycle tonewheel input pulse must be present (tonewheel running) and the correct voltages must be applied to the chassis.

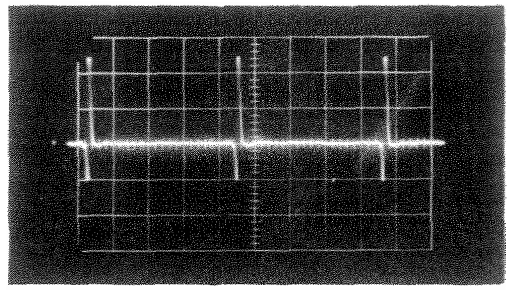
Typical waveforms (figures TWA-18 through TWA-21) and the *Voltage Table* (adjacent to the schematic diagram, figure TWA-23) may be used in conjunction with the *Trouble Shooting Chart* to facilitate trouble shooting.

TROUBLE SHOOTING CHART

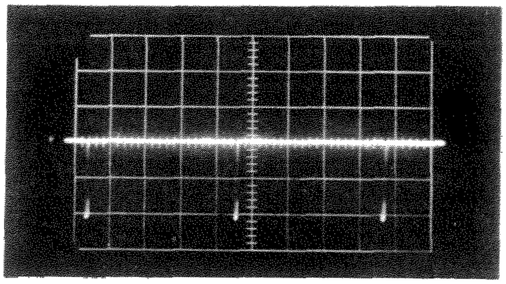
Symptom	*Corrective Action*	*See Figure*
No filament voltage.	Check fuse (1½ ampere, slo-blo). If replacement fuse blows immediately, eliminate short before inserting another fuse.	
Low amplitude of 240-cycle tonewheel head input pulse at J1 (240 IN). (Less than 1.0 volt peak-to-peak.)	Reposition tonewheel head with respect to tonewheel rim by moving head closer to rim. (Before making this adjustment, the set-screw provided on the tonewheel head mounting must be loosened.) *CAUTION: To prevent damage to the tonewheel head, do not allow the head to come in contact with the tonewheel rim.* Check resistors R1 and R8. (Approximately 240 volts dc should appear at pin 1 of J1 with tonewheel head disconnected.)	
No output signals.	Check for correct 240-cycle pulse input at TP1 (TW INPUT). Ascertain that normal operating voltages are applied to unit. Check amplifier and regenerative clipper stages V1 and V2 at TP2 (PULSE V2).	TWA-18A TWA-18D
Incorrect or no output at J2 (240 OUT PULSE) with normal output at J3.	Check waveform at TP3 (PULSE V4) with low capacity oscilloscope probe. If waveform is incorrect, check multivibrator V4 and associated circuit components. If waveform at TP3 is correct, check multivibrator V5, output tube V6, and associated circuit components.	TWA-18E, F TWA-18G
Incorrect or no output at J3 (240 OUT SQ. WAVE) with normal output at J2.	Isolate trouble by a point-to-point check of multivibrators V7 and V9, and output stage V10.	TWA-19A, B, C, D, E
Incorrect or no output at J4 (960 OUT) with normal output at J2.	Check waveform at TP8 (SYMMETRY 960). If the correct waveform is present, check multivibrators V12 and V13, output tube V14, and associated circuit components. If the normal waveform does not appear at TP8, check multivibrator V19 and the 960-cycle oscillator stage. NOTE: Replacement of oscillator tube V18, or components in the oscillator circuit, will necessitate readjustment of the 960-cycle frequency. This adjustment is critical, and the procedure outlined under *960-cycle Oscillator Frequency* adjustment should be closely followed.	TWA-20A, C, D, E, F, G TWA-20A, B
Incorrect or no trapezoidal waveform at TP9 (PHASE 960).	Check for correct waveform at TP8 (SYMMETRY 960). If normal waveform is present, check peak-to-peak voltage at cathode (pin 3) of cathode follower V20A (approximately 40 volts). Also check for defective shaper and clamper stage V16, and cathode follower stage V20B. If normal waveform is not present at TP8, check multivibrator V19 and 960-cycle oscillator V18 as noted above.	TWA-20A TWA-21C, D TWA-20A, B
Failure of 960-cycle oscillator to lock on 240-cycle pulse.	Make sure AFC switch is ON. Check *960-Cycle Oscillator Frequency* adjustment. Check *960-Cycle Phase* adjustment. Check discriminator (V21) and associated circuit components. Check for open capacitor C55, or high resistance ground contact at this point. Check afc control tube (V17) and associated circuit components.	 TWA-21E, F TWA-21G



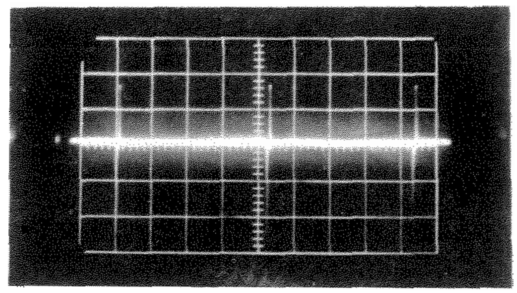
A. TP1 (T.W. INPUT). 0.5v/cm; 1000 usec/cm



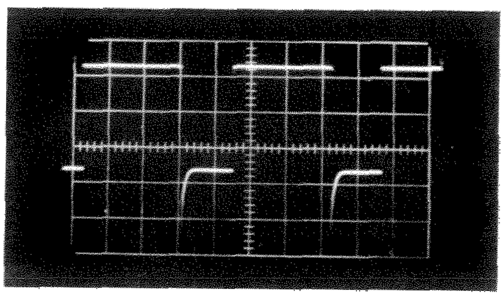
B. V1, Pin 6. 20v/cm; 1000 usec/cm



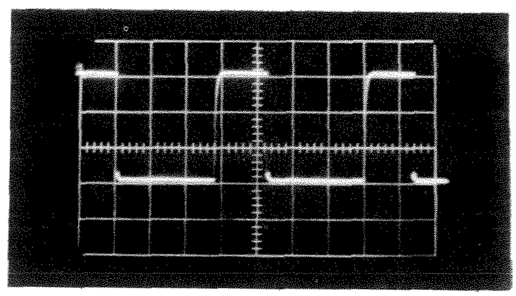
C. V2, Pin 1. 20v/cm; 1000 usec/cm



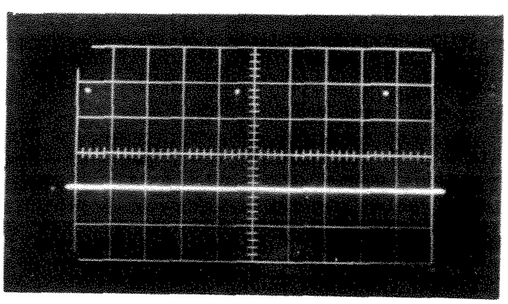
D. TP2 (PULSE V2). 5v/cm; 1000 usec/cm



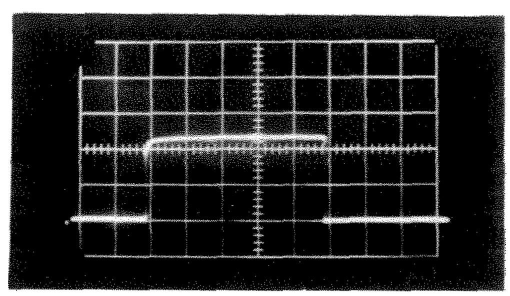
E. V4, Pin 1. 20v/cm; 1000 usec/cm



F. TP3 (PULSE V4). 50v/cm; 1000 usec/cm

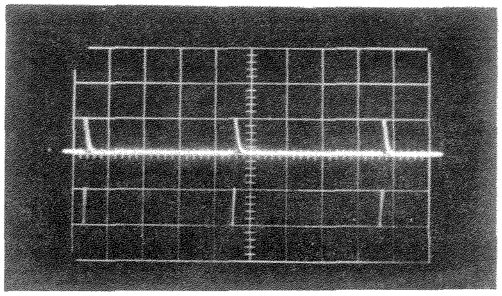


G. V5, Pin 8. 5v/cm; 1000 usec/cm

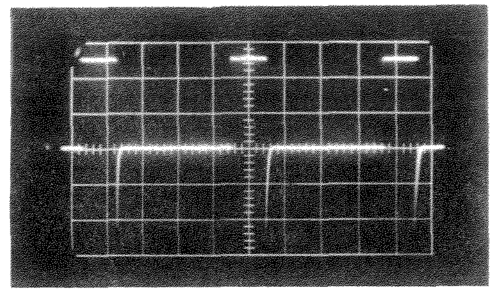


H. TP4 (OUTPUT 240 PULSE). 2v/cm; 10 usec/cm

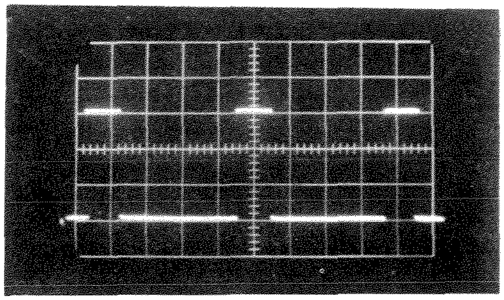
Figure TWA-18. Typical Waveforms



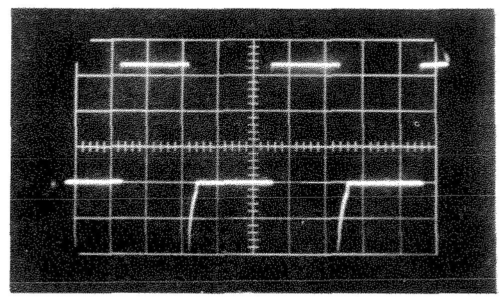
A. V8, Pin 1. 50v/cm; 1000 usec/cm



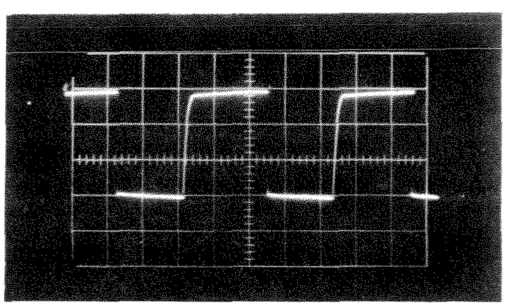
B. V7, Pin 1. 20v/cm; 1000 usec/cm



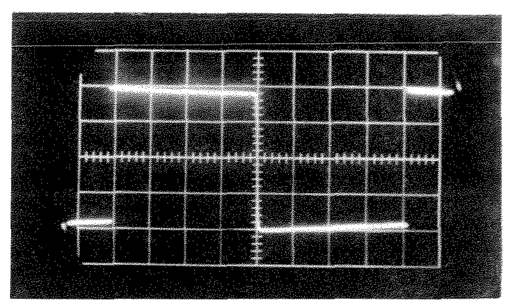
C. V7, Pin 8. 10v/cm; 1000 usec/cm



D. V9, Pin 1. 20v/cm; 1000 usec/cm

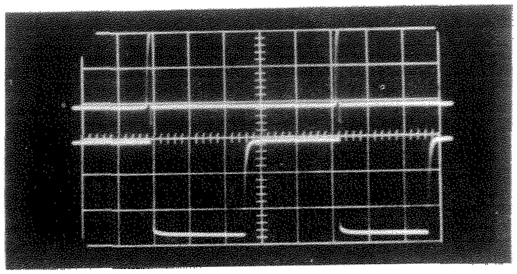


E. V9, Pin 6. 50v/cm; 1000 usec/cm

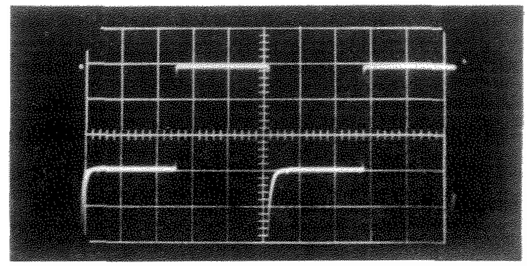


F. TP5 (OUTPUT 240 SQ. WAVE).
1v/cm; 500 usec/cm

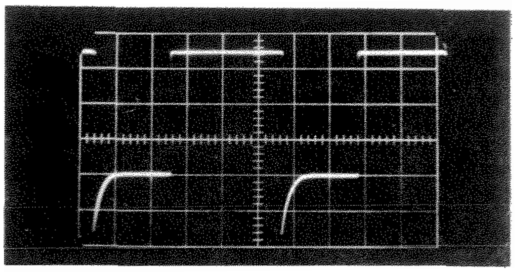
Figure TWA-19. Typical Waveforms



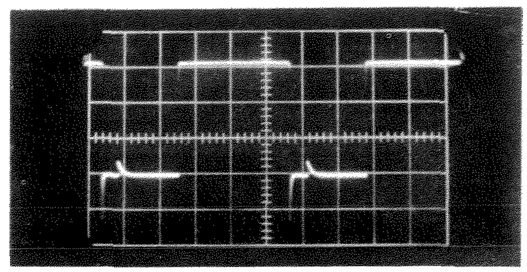
A. Top: TP7 (FREQUENCY 960).
20v/cm; 200 usec/cm
Bottom: TP8 (SYMMETRY 960).
50v/cm; 200 usec/cm



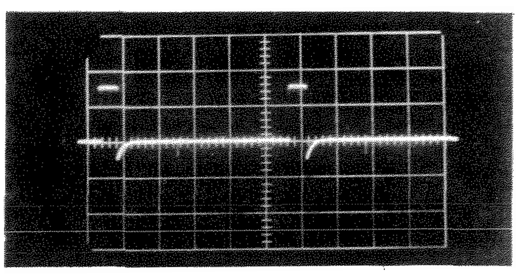
B. V19, Pin 1. 20v/cm; 200 usec/cm



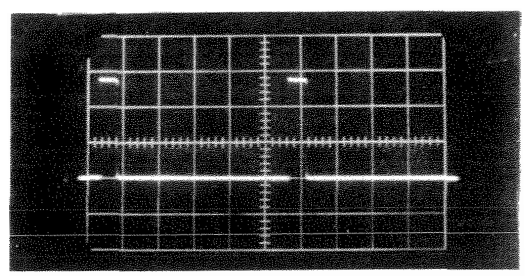
C. V12, Pin 1. 20v/cm; 200 usec/cm



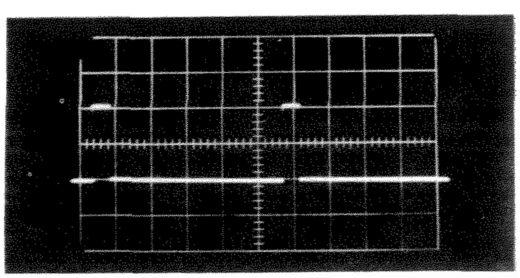
D. V12, Pin 8. 10v/cm; 200 usec/cm



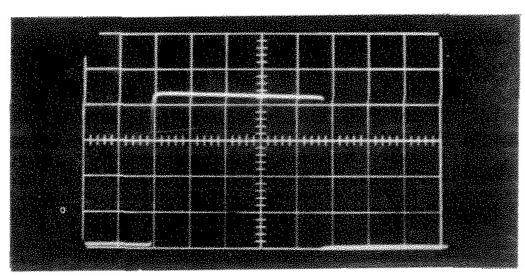
E. V13, Pin 1. 50v/cm; 200 usec/cm



F. V13, Pin 8. 20v/cm; 200 usec/cm

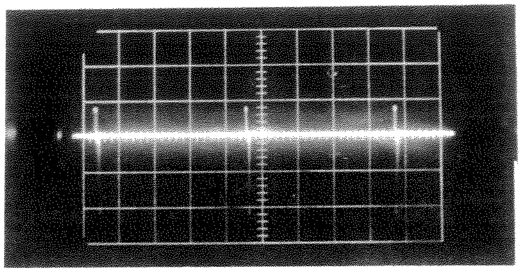


G. V14, Pins 3 and 6.
2v/cm; 200 usec/cm

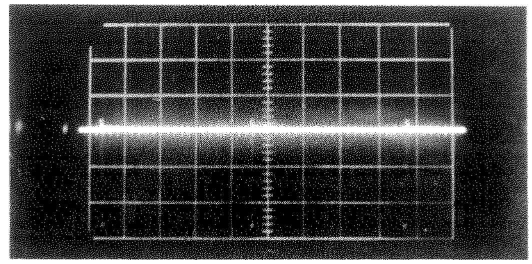


H. TP6 (OUTPUT 960).
1v/cm; 20 usec/cm

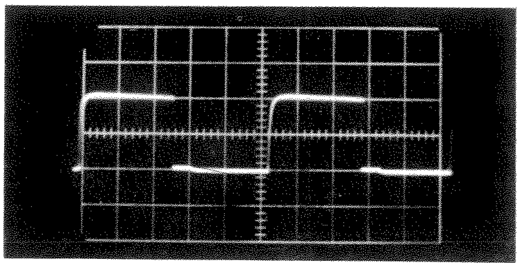
Figure TWA-20. Typical Waveforms



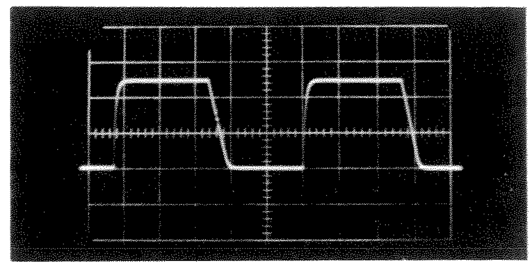
A. V11, Pin 1. 50v/cm; 1000 usec/cm



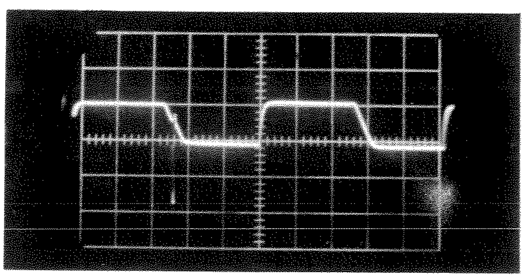
B. V11, Pin 6. 100v/cm; 1000 usec/cm



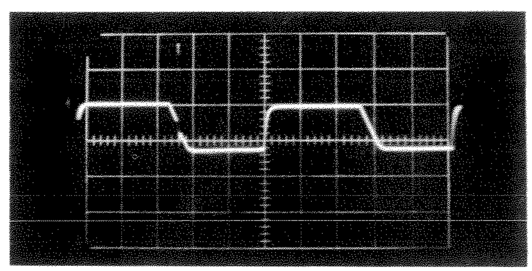
C. V20, Pin 3. 20v/cm; 200 usec/cm



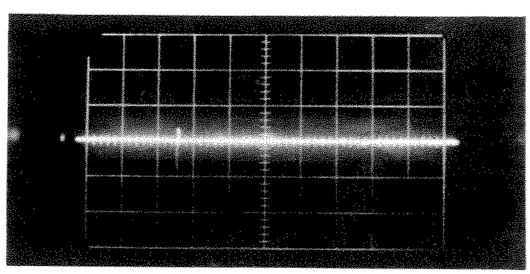
D. TP9 (PHASE 960). 5v/cm; 200 usec/cm



E. V21, Pin 5. 10v/cm; 200 usec/cm



F. V21, Pin 7. 10v/cm; 200 usec/cm



G. V17, Pin 3. 1v/cm; 200 usec/cm

Figure TWA-21. Typical Waveforms

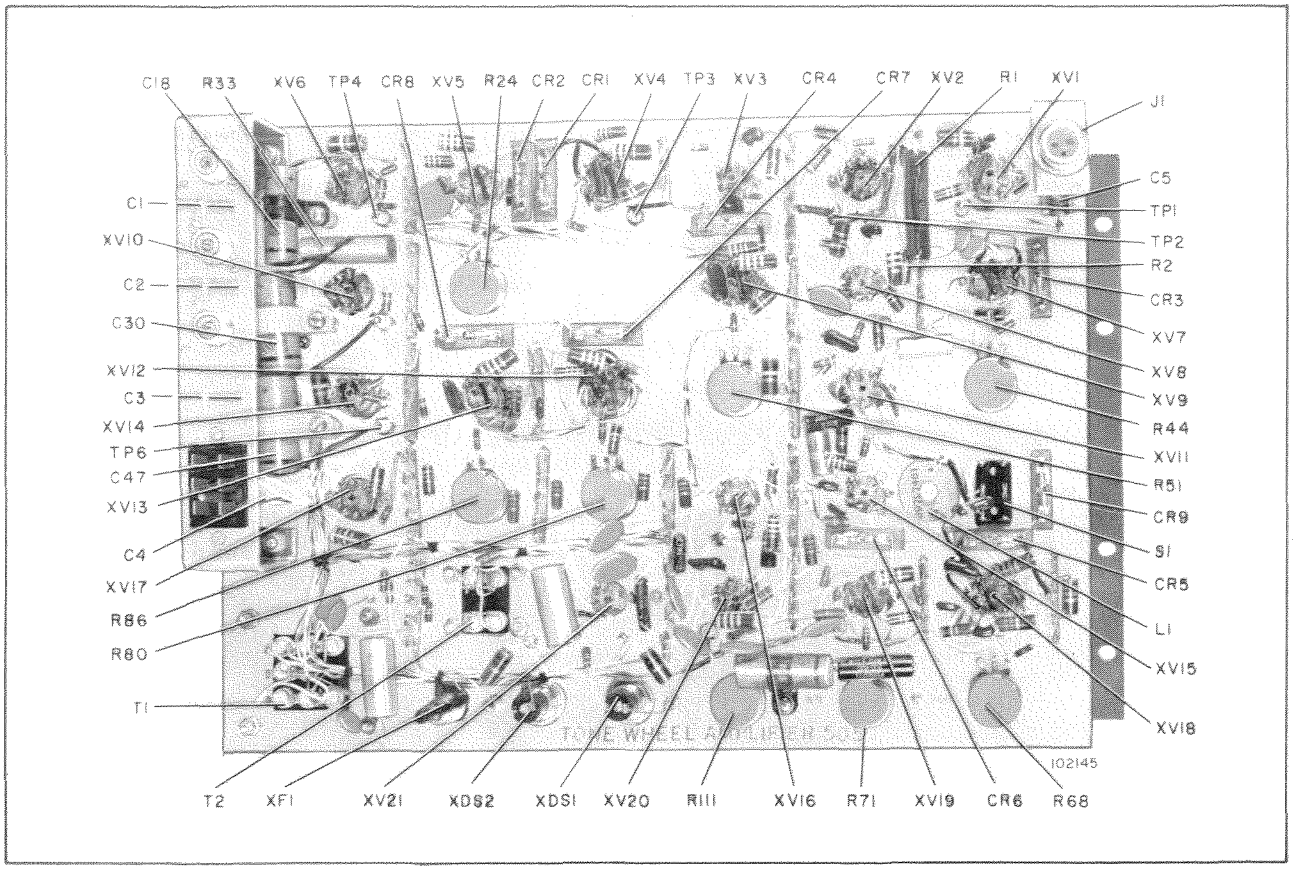


Figure TWA-22. Tonewheel Amplifier Rear View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
TONE WHEEL AMPLIFIER (8974479-501)			6
			CAPACITORS:
C1A/D	98408	458558-5	electrolytic, 20/20/20/20 μf +50 -10%, 450 v
C2A/D, C3A/D	98986	458558-10	electrolytic, 10/10/10/10 μf +50 -10%, 450 v
C4A/B	99295	458557-5	electrolytic, 20/20 μf +50 -10%, 450 v
C5	212546	459684-33	paper, 0.01 μf ±20%, 400 v
C6, C7		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C8		8924416-303	mica, 510 μμf ±5%, 500 v char "F"
C9		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C10		748252-310	mica, 10 μμf ±5%, 500 v char "C"
C11, C12		8924416-304	mica, 560 μμf ±5%, 500 v char "F"
C13	218465	8924416-210	mica, 1000 μμf ±2%, 500 v
C14		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
C15		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C16		8914319-326	mica, 120 μμf ±5%, 500 v char "F"
C17	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C18	212553	8958264-37	electrolytic, 50 μf, 50 v
C19, C20			Not Used
C21	96999	737816-89	paper, 0.022 μf ±10%, 400 v
C22	217263	737816-335	paper, 0.22 μf ±10%, 100 v
C23		8924416-319	mica, 2700 μμf ±5%, 500 v char "F"
C24	217263	737816-335	paper, 0.22 μf ±10%, 100 v
C25		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
C26		8924416-316	mica, 1800 μμf ±5%, 500 v char "F"
C27		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
C28		8924416-319	mica, 2700 μμf ±5%, 500 v char "F"

Symbol No.	Stock No.	Drawing No.	Description
C29	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C30	59417	8958264-52	electrolytic, 40 μf 150 v
C31, C32			Not Used
C33		8914319-336	mica, 330 μμf ±5%, 500 v char "F"
C34		8914319-344	mica, 680 μμf ±5%, 300 v char "F"
C35	212473	737816-55	paper, 0.22 ±10%, 200 v
C36	218466	8924416-212	mica, 1200 μμf ±2%, 500 v
C37		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
C38	218474	8929295-206	mica, 6200 μμf ±2%, 500 v
C39		8914319-332	mica, 220 μμf ±5%, 500 v char "F"
C40, C41	218127	8976580-2	ceramic, 0.05 μf -20 +80%, 500 v
C42		8914319-318	mica, 56 μμf ±5%, 500 v char "E"
C43		8924416-306	mica, 680 μμf ±5%, 500 v char "F"
C44		8914319-324	mica, 100 μμf ±5%, 500 v char "F"
C45		8924416-304	mica, 560 μμf ±5%, 500 v char "F"
C46	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C47	59417	8958264-52	electrolytic, 40 μf, 150 v
C48	210137	8958264-65	electrolytic, 10 μf 250 v
C49			Not Used
C50		8924416-323	mica, 3900 μμf ±5%, 300 v char "F"
C51 to C55	218097	8976580-1	ceramic, 0.1 μf -20 +80%, 500 v
C56 to C58		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C59, C60	215250	737816-415	paper, 0.22 μf ±10%, 400 v
C61 to C63		8811182-5	ceramic, 10,000 μμf -20 +100%, 450 v
C65A/B to C72A/B	218128	8971848-10	ceramic, 0.005/0.005 μf -20 +80%, 150 v
CR1 to CR9	59395	8981515-1	Diode: 1N34A
DS1, DS2	101857	872291-9	Lamp: indicator
F1	98682	990157-109	Fuse: 1.5 amp 125 v, slo-blo
J1	219414	8978091-12	Connector: female, 3 contact, chassis mtg.
J2 to J4	51800	255223-2	Connector: coax, chassis mtg.
J5	51604	727969-3	Connector: male, 6 contact, chassis mtg.
L1	218475	8979746-1	Reactor: R.F. choke
P1		8978091-14	Connector: male, 3 cont., cable mtg.
P2 to P4			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adapter - solder type
P5	51607	727969-4	Connector: female, 6 cont, cable mtg.
			RESISTORS:
			Fixed, Composition - unless otherwise specified
R1	48751	878434-24	wire wound, 4000 ohm ±10%, 20 w
R2		90496-207	100,000 ohm ±5%, 1 w
R3		82283-225	560,000 ohm ±5%, ½ w
R4		90496-183	10,000 ohm ±5%, 1 w
R5		82283-151	470 ohm ±5%, ½ w
R6	45515	458574-56	wire wound, 2500 ohm ±5%, 10 w
R7		99126-183	10,000 ohm ±5%, 2 w
R8		82283-209	120,000 ohm ±5%, ½ w
R9		82283-139	150 ohm ±5%, ½ w
R10		82283-217	270,000 ohm ±5%, ½ w
R11		82283-183	10,000 ohm ±5%, ½ w
R12		82283-201	56,000 ohm ±5%, ½ w
R13		90496-175	4700 ohm ±5%, 1 w
R14		99126-183	10,000 ohm ±5%, 2 w
R15		82283-215	220,000 ohm ±5%, ½ w
R16		82283-205	82,000 ohm ±5%, ½ w
R17		90496-175	4700 ohm ±5%, 1 w
R18		82283-223	470,000 ohm ±5%, ½ w
R19		82283-246	4.3 meg ±5%, ½ w
R20		90496-183	10,000 ohm ±5%, 1 w
R21		99126-195	33,000 ohm ±5%, 2 w
R22		90496-195	33,000 ohm ±5%, 1 w
R23		82283-223	470,000 ohm ±5%, ½ w
R24	92231	8971860-118	variable, 1 meg ±20%, 2 w
R25		82283-215	220,000 ohm ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R26		90496-183	10,000 ohm ±5%, 1 w
R27		90496-195	33,000 ohm ±5%, 1 w
R28		99126-195	33,000 ohm ±5%, 2 w
R29		82283-170	3000 ohm ±5%, ½ w
R30		82283-217	270,000 ohm ±5%, ½ w
R31, R32		82283-135	100 ohm ±5%, ½ w
R33		99126-183	10,000 ohm ±5%, 2 w
R34		82283-159	1000 ohm ±5%, ½ w
R35		82283-151	470 ohm ±5%, ½ w
R36			Not Used
R37		82283-171	3300 ohm ±5%, ½ w
R38		90496-159	1000 ohm ±5%, 1 w
R39		99126-183	10,000 ohm ±5%, 2 w
R40		82283-223	470,000 ohm ±5%, ½ w
R41		82283-209	120,000 ohm ±5%, ½ w
R42		90496-165	1800 ohm ±5%, 1 w
R43		82283-223	470,000 ohm ±5%, ½ w
R44	213201	8971860-20	variable, 2.5 meg ±20%, 2 w
R45		82283-217	270,000 ohm ±5%, ½ w
R46		90496-183	10,000 ohm ±5%, 1 w
R47		90496-195	33,000 ohm ±5%, 1 w
R48		99126-195	33,000 ohm ±5%, 2 w
R49		82283-181	8200 ohm ±5%, ½ w
R50		82283-223	470,000 ohm ±5%, ½ w
R51	92231	8971860-118	variable, 1 meg ±20%, 2 w
R52		82283-230	910,000 ohm, ±5%, ½ w
R53		90496-195	33,000 ohm ±5%, 1 w
R54		90496-183	10,000 ohm ±5%, 1 w
R55		99126-195	33,000 ohm ±5%, 2 w
R56		82283-230	910,000 ohm ±5%, ½ w
R57		82283-135	100 ohm ±5%, ½ w
R58	45258	458572-62	wire wound, 3000 ohm ±5%, 5 w
R59		82283-142	200 ohm ±5%, ½ w
R60		82283-135	100 ohm ±5%, ½ w
R61 to R63			Not Used
R64		99126-179	6800 ohm ±5%, 2 w
R65		99126-177	5600 ohm ±5%, 2 w
R66		90496-183	10,000 ohm ±5%, 1 w
R67		82283-238	2.0 meg ±5%, ½ w
R68	97961	8971860-117	variable, 500,000 ohm ±10%, 2 w
R69		82283-215	220,000 ohm ±5%, ½ w
R70		99126-179	6800 ohm ±5%, 2 w
R71	92231	8971860-118	variable, 1 meg ±20%, 2 w
R72		82283-243	3.3 meg ±5%, ½ w
R73		90496-195	33,000 ohm ±5%, 1 w
R74		90496-183	10,000 ohm ±5%, 1 w
R75		99126-195	33,000 ohm ±5%, 2 w
R76		82283-181	8200 ohm ±5%, ½ w
R77		82283-233	1.2 meg ±5%, ½ w
R78		90496-137	120 ohm ±5%, 1 w
R79		82283-223	470,000 ohm ±5%, ½ w
R80	95242	8971860-18	variable, 1 meg ±20%, 2 w
R81		82283-230	910,000 ohm ±5%, ½ w
R82		90496-183	10,000 ohm ±5%, 1 w
R83		90496-195	33,000 ohm ±5%, 1 w
R84		99126-195	33,000 ohm ±5%, 2 w
R85		82283-181	8200 ohm ±5%, ½ w
R86	97961	8971860-117	variable, 500,000 ohm ±10%, 2 w
R87		82283-215	220,000 ohm ±5%, ½ w
R88		90496-183	10,000 ohm ±5%, 1 w
R89		90496-195	33,000 ohm ±5%, 1 w
R90		99126-195	33,000 ohm ±5%, 2 w
R91		82283-189	18,000 ohm ±5%, ½ w
R92		82283-223	470,000 ohm ±5%, ½ w
R93, R94		82283-135	100 ohm ±5%, ½ w

Symbol No.	Stock No.	Drawing No.	Description
R95		82283-151	470 ohm ±5%, ½ w
R96		99126-183	10,000 ohm ±5%, 2 w
R97		82283-159	1000 ohm ±5%, ½ w
R98 to R100			Not used
R101, R102		90496-155	680 ohm ±5%, 1 w
R103		82283-225	560,000 ohm ±5%, ½ w
R104		99126-195	33,000 ohm ±5%, 2 w
R105		82283-171	3300 ohm ±5%, ½ w
R106		82283-219	330,000 ohm ±5%, ½ w
R107, R108		90496-155	680 ohm ±5%, 1 w
R109		99126-193	27,000 ohm ±5%, 2 w
R110		82283-221	390,000 ohm ±5%, ½ w
R111	93175	8971860-110	variable, 10,000 ohm ±10%, 2 w
R112		90496-197	39,000 ohm ±5%, 1 w
R113	215169	990730-301	film, 1000 ohm ±1%, ½ w
R114, R115		90496-155	680 ohm ±5%, 1 w
R116	208022	990730-601	film, 1 meg ±1%, ½ w
R117	215169	990730-301	film, 1000 ohm ±1%, ½ w
R118	208022	990730-601	film, 1 meg ±1%, ½ w
R119		82283-135	100 ohm ±5%, ½ w
R120, R121		90496-155	680 ohm ±5%, 1 w
R122		99126-199	47,000 ohm ±5%, 2 w
R123		82283-193	27,000 ohm ±5%, ½ w
R124			Not Used
R125		82283-90	220,000 ohm ±10%, ½ w
R126			Not Used
R127		82283-85	82,000 ohm ±10%, ½ w
R128, R129		82283-90	220,000 ohm ±10%, ½ w
R130, R131		99126-111	10 ohm ±5%, 2 w
R132			Part of XDS1
R133		82283-87	120,000 ohm ±10%, ½ w
R134			Part of XDS1
R135		82283-94	470,000 ohm ±10%, ½ w
S1	93263	95559-5	Switch: toggle, DPDT
T1	95539	450031-3	Transformer: filament
T2	51936	895314-1	Transformer: phase discriminator coupling
TP1 to TP9	208983	8825493-7	Jack: tip, yellow
XADS1, XADS2	208080	990788-507	Lens: indicator light
XDS1, XDS2	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
XV1, XV2	94926	737870-14	Socket: tube, 9 pin
XV3	94925	737867-14	Socket: tube, 7 pin
XV4 to XV7	94926	737870-14	Socket: tube, 9 pin
XV8	94925	737867-14	Socket: tube, 7 pin
XV9 to XV14	94926	737870-14	Socket: tube, 9 pin
XV15, XV16	94925	737867-14	Socket: tube, 7 pin
XV17 to XV20	94926	737870-14	Socket: tube, 7 pin
			Miscellaneous:
	205329	741622-501	Knob: control
	218920	8980029-501	Holder: crystal

VOLTAGE CHART†

Tube Symbol	Tube Type	Pin Number								
		1	2	3	4	5	6	7	8	9
V1	5670	****	1.7	0	120	NC	100	−0.1	0.8	****
V2	12AT7	275	49	76	*	*	250	75	76	*
V3	6AL5	280	180	***	***	280	NC	280	NC	NC
V4	12AT7	−19	−180	−150	*	*	180	−19	0.3	*
V5	12AT7	−62	−150	−150	*	*	280	−62	−12	*
V6	5687	280	0	55	**	**	55	0	**	280
V7	12AT7	−56	−160	−150	*	*	250	−56	−23	*
V8	6AL5	280	210	***	***	275	NC	250	NC	NC
V9	12AT7	−38	−175	−150	*	*	210	−38	0.35	*
V10	5687	100	−60	GND	**	**	115	100	**	210
V11	12BH7A	200	0	8	*	*	280	−30	0	*
V12	12AT7	−33	−180	−150	*	*	200	−33	−14	*
V13	12AT7	−68	−155	−150	*	*	270	−68	−47	*
V14	5687	280	0	50	**	**	50	0	**	280
V15	6AL5	280	200	***	***	275	NC	210	NC	NC
V16	6AL5	7	−8	***	***	−7.5	NC	−8	NC	NC
V17	12AU7	280	−18	−1	*	*	NC	NC	NC	*
V18	12AT7	180	−0.1	1.4	*	*	−0.1	−62	−86	*
V19	12AT7	−30	−170	−150	*	*	210	−30	−14	*
V20	12AU7	280	−46	7	*	*	280	−7.5	5	*
V21	6AL5	−19	−19	***	***	1.5	NC	−37	NC	NC

† Typical (±10%) dc voltages from tube-sockets to ground using a vacuum-tube voltmeter.
* 6.3 volts ac between pin 9 and either of pins 4 or 5.
** 6.3 volts ac between pin 8 and either of pins 4 or 5.
*** 6.3 volts ac between pins 3 and 4.
**** 6.3 volts ac between pins 1 and 9.

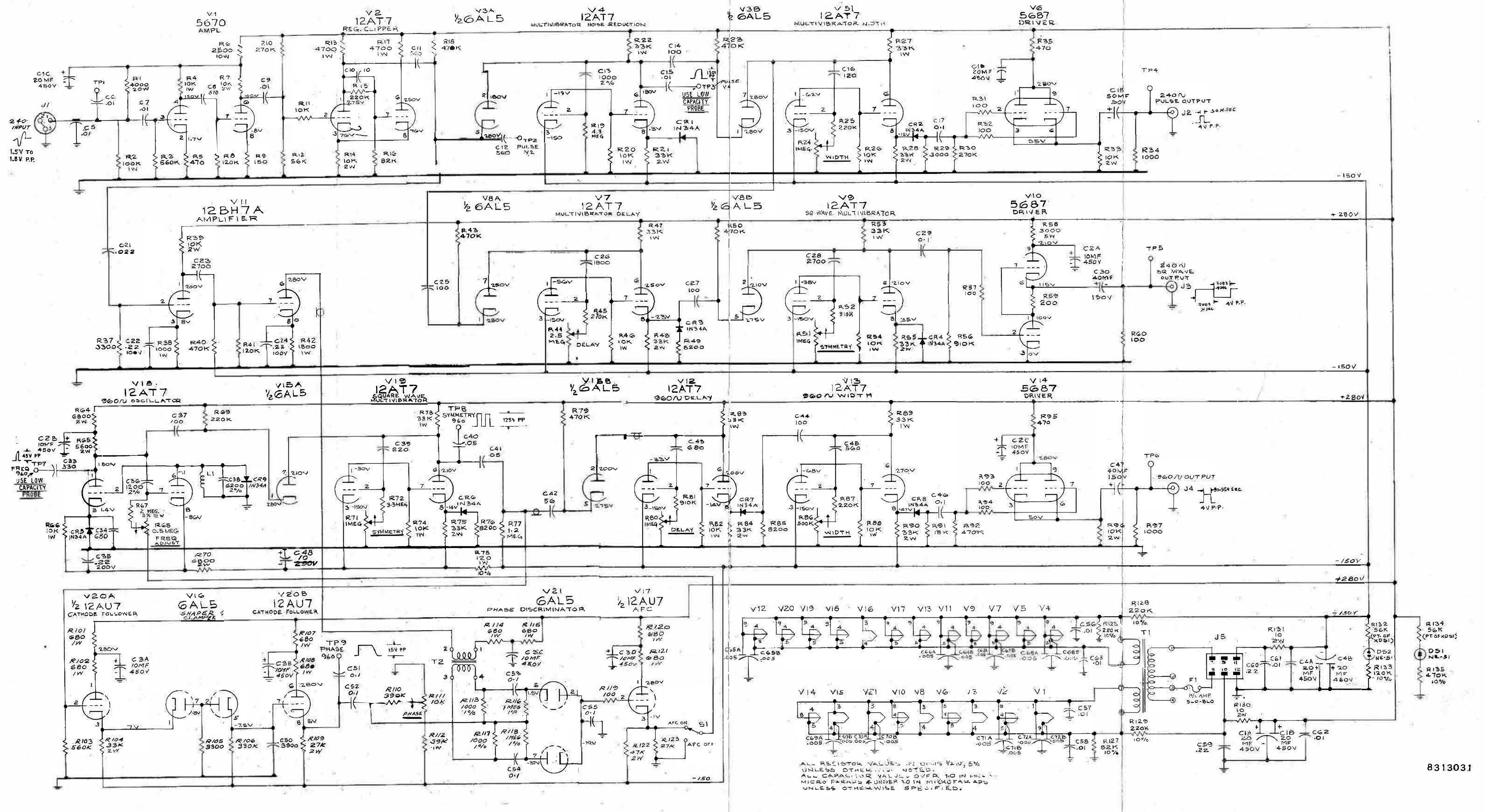


Figure TWA-23. Schematic Diagram of Tonewheel Amplifier

ELECTRONIC RECORDING PRODUCTS

Vacuum Guide Servo

UNIT 506

RADIO CORPORATION OF AMERICA

INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WB 671

IB-31153

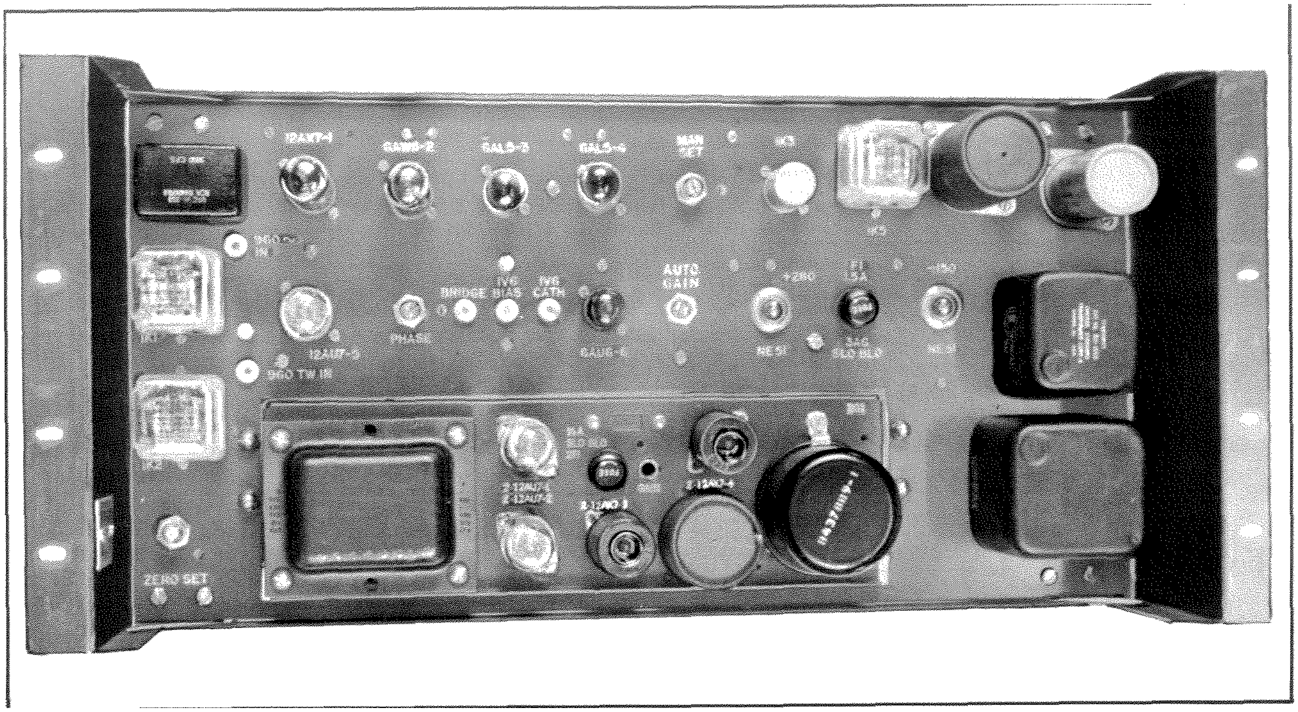


Figure VGS-1. Vacuum Guide Servo

TECHNICAL DATA

Power Required

AC: 117 volts, 50/60 cycles, 30 watts
(from circuit breaker No. 5)

DC: +280, 50 ma., (from unit No. 410)
−150, 5 ma., (from unit No. 405)

Input Signals

960 cps error signal from the 2 x 1 switcher

960 cps tonewheel pulse from the tonewheel amplifier (4.0 volts p-p)

Output Signals

60 cps, 2 phase to the vacuum guide motor

DESCRIPTION

The purpose of the vacuum guide servo system is to control the position of the vacuum guide which directs the tape into contact with the rotating video headwheel. To provide the head-to-tape contact required for recording at very high frequencies, the position of the vacuum guide is so adjusted that the rotating heads indent the tape to about the degree indicated by the scale drawing in figure VGS-2. In addition to providing good head-to-tape contact, the slight stretching of the tape resulting from the indentation of the video heads is necessary to compensate for head wear.

In the record mode, the vacuum guide is maintained in a fixed position which is determined by the setting of the RECORD GUIDE POSITION control on the control panel. In the playback mode, the vacuum guide position can be controlled automatically (by servo action) or adjusted manually. This mode of operation depends upon the position of the control panel GUIDE POSITION switch (AUTOMATIC-MANUAL).

If the vacuum guide position is not correct, the relative head-to-tape speed is not quite correct and there will be slight timing errors in the output signal. The average timing remains correct, however, because the angular velocity of the headwheel is maintained at its proper value by the headwheel servo system. The timing errors appear in the form discontinuities at the instant of switch from head to head as indicated in figure VGS-3. While only horizontal sync pulses are shown the same timing errors also occur for all picture signal components.

If a train of pulses containing slight timing discontinuities is applied to a horizontal oscillator of the synchroguide type with a "flywheel" time constant somewhat greater than the 16-line head-scanning interval, it is possible to develop a steady train of average-frequency pulses in which the timing variations are eliminated, as shown at (c) and (f) in figure VGS-3. Since most horizontal-deflection circuits in television receivers behave in this general

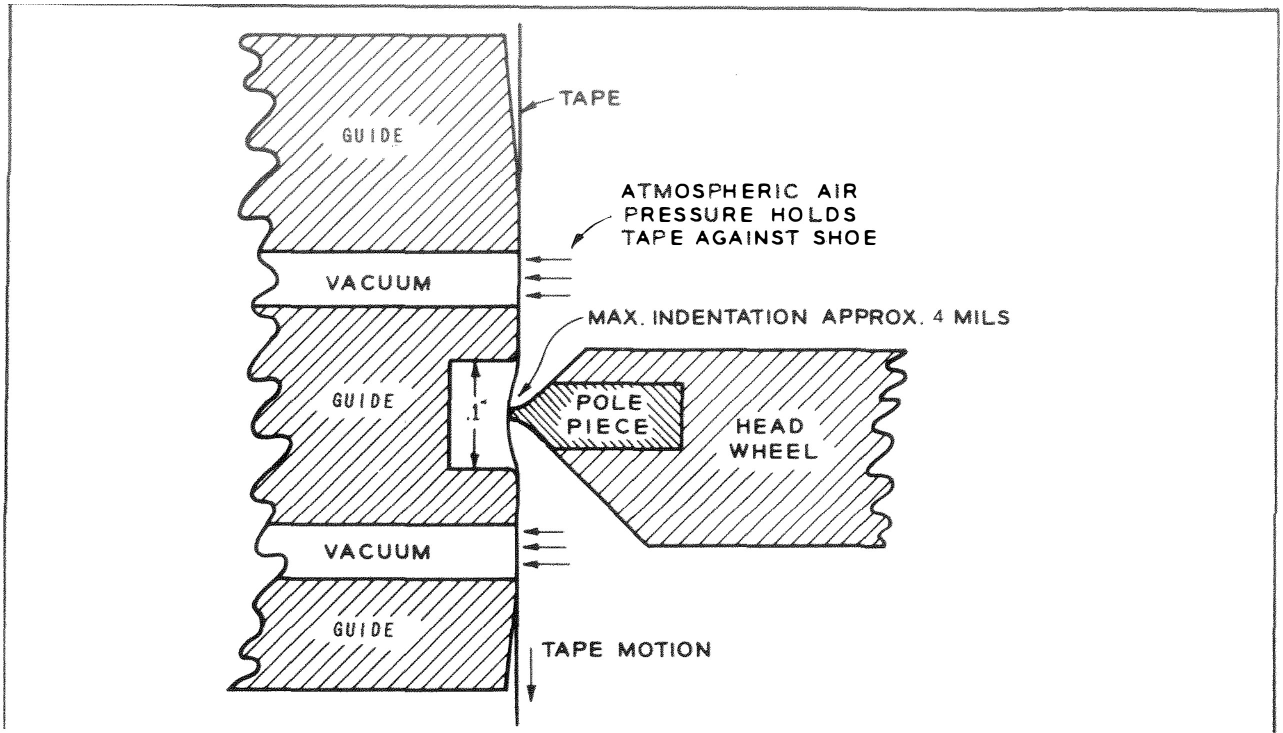


Figure VGS-2. Cross-Section Drawing of the Tape Guiding Shoe and Video Head-Wheel, Illustrating the Indentation of the Tape by the Video Heads

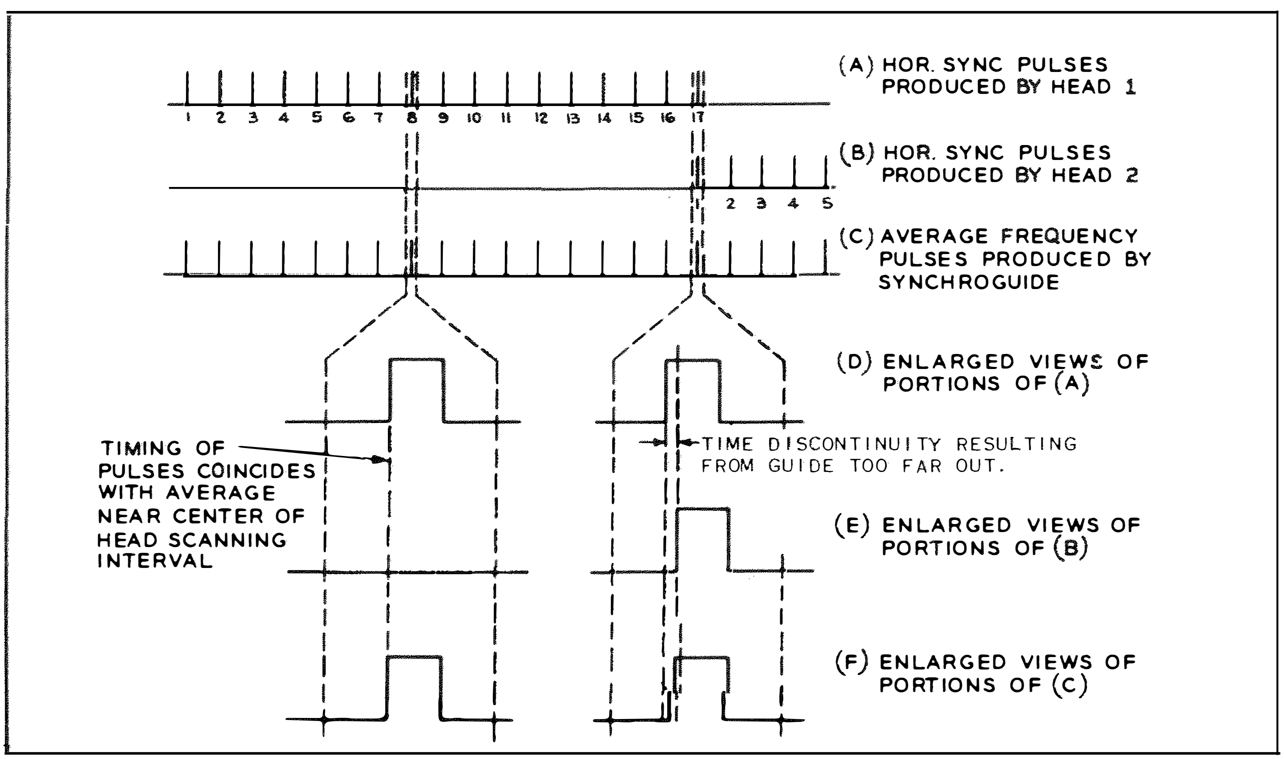


Figure VGS-3. Waveform Sketches Illustrating Timing Errors Resulting from Shoe Position Errors

fashion, the appearance of guide position errors in television pictures is about as indicated in figure VGS-4. The "flywheel" effect in the deflection oscillator causes the line scanning to occur at essentially constant frequency, but the timing errors in blanking and all other signal components causes an effect that various people have called "jogging", "skew", or the "venetian blind effect." The jogs occur in bands of 16 lines per field, or 32 lines in properly interlaced frames, since approximately 16 lines are recorded during each head-scanning interval. The figure illustrates the effect of the guide being too far out. If the guide is too far in the result is very similar, but the "jogs" slope in the opposite direction. As a rough "rule of thumb", an error of about 1 mil in guide position results in jogs that are offset by about 1.25% of the picture width. Guide position is correct at the point where the jogs completely disappear.

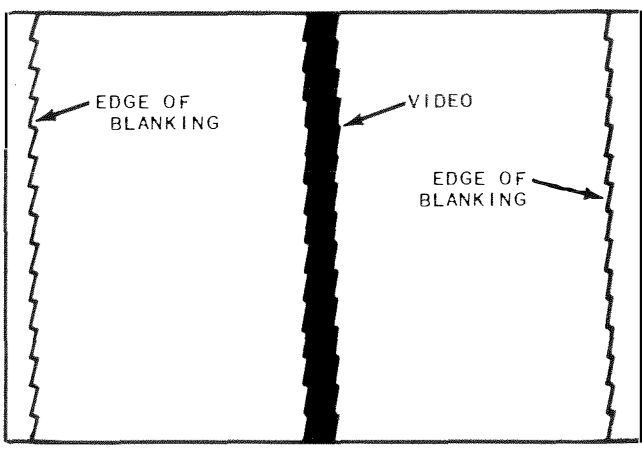


Figure VGS-4. Sketch of a Television Raster Showing Effect Produced by Inadequate Head-to-Tape Pressure Resulting from an Error of About 1 mil of Guide Positioner

Circuit

A simplified block diagram of the Vacuum Guide Servo System is presented in figure VSG-5. The main output device for the system is a motor that normally remains stationary, and moves only slightly in one direction or the other in response to error signals. With the guide servo system in the automatic mode, the motor automatically seeks to position itself so as to keep the error signal at zero.

The main error detector for the vacuum guide servo system is not mounted on the vacuum guide chassis, but is located on the 2 x 1 switcher (where it also performs additional functions related to the head-switching and sync restoration operations). The error is detected by a circuit tuned to 960 cps inserted in the plate circuit of the synchroguide's control tube. The polarity of the 960 cps signal developed in this circuit indicates the direction of the timing errors. In the circuitry on the guide servo chassis, the 960-cps signal is amplified, and rectified. To preserve the direction sense in the error signal, the rectifier is a bi-directional type, utilizing 960 cps clamping pulses derived from the tone-wheel attached to the head-wheel motor. The rectifier produces a fixed d-c level of a polarity indicating the direction of the error. The rectified error signal is converted to a 60 cps signal by the action of a chopper-type modulator, and then amplified to the power level necessary to drive the guide positioning motor. The motor is a two-phase type in which one phase is continuously excited by the power line, while the other is driven by the amplifier. The motor develops torque only when a signal is delivered by the amplifier, and the direction of this torque depends upon the polarity of the amplifier signal. The motor then drives the guide through an appropriate mechanical coupling. The motor movement is limited to only a few revolutions, and the maximum displacement required for the guide is only about 5 mils. The servo loop is completed through the FM system, video playback system, and a sync separator in the 2 x 1 switcher chassis.

A simplified servo loop is used for manual positioning of the guide during recording operations and during special cases of playback operation. The switches shown in figure VGS-5 are relay contacts, controlled by switches on the main control panel and interlocked with the main RECORD and PLAY buttons. For manual operation (record or play), the setting of a potentiometer on the motor shaft is compared with the setting of a second potentiometer which is mounted on the control panel. The motor turns until the voltage at the arm of the motor potentiometer is the same as that on the manual SHOE POSITION control, resulting in zero signal at the output of the chopper. Through the use of this relatively simple positioning-type servo, the manual SHOE POSITION control is, in effect, directly coupled to the motor shaft.

960 cps Error Signal Amplifier—The amplifying circuits for the 960 cps error signal developed in the synchroguide are shown in figure VGS-6. A "packaged" 2000 cps low-pass filter is used to eliminate the line-frequency components which are also present in the synchroguide output. Stage 1V1A is a conventional voltage amplifier, with the AUTO GAIN control located in the plate circuit. The adjustable phase

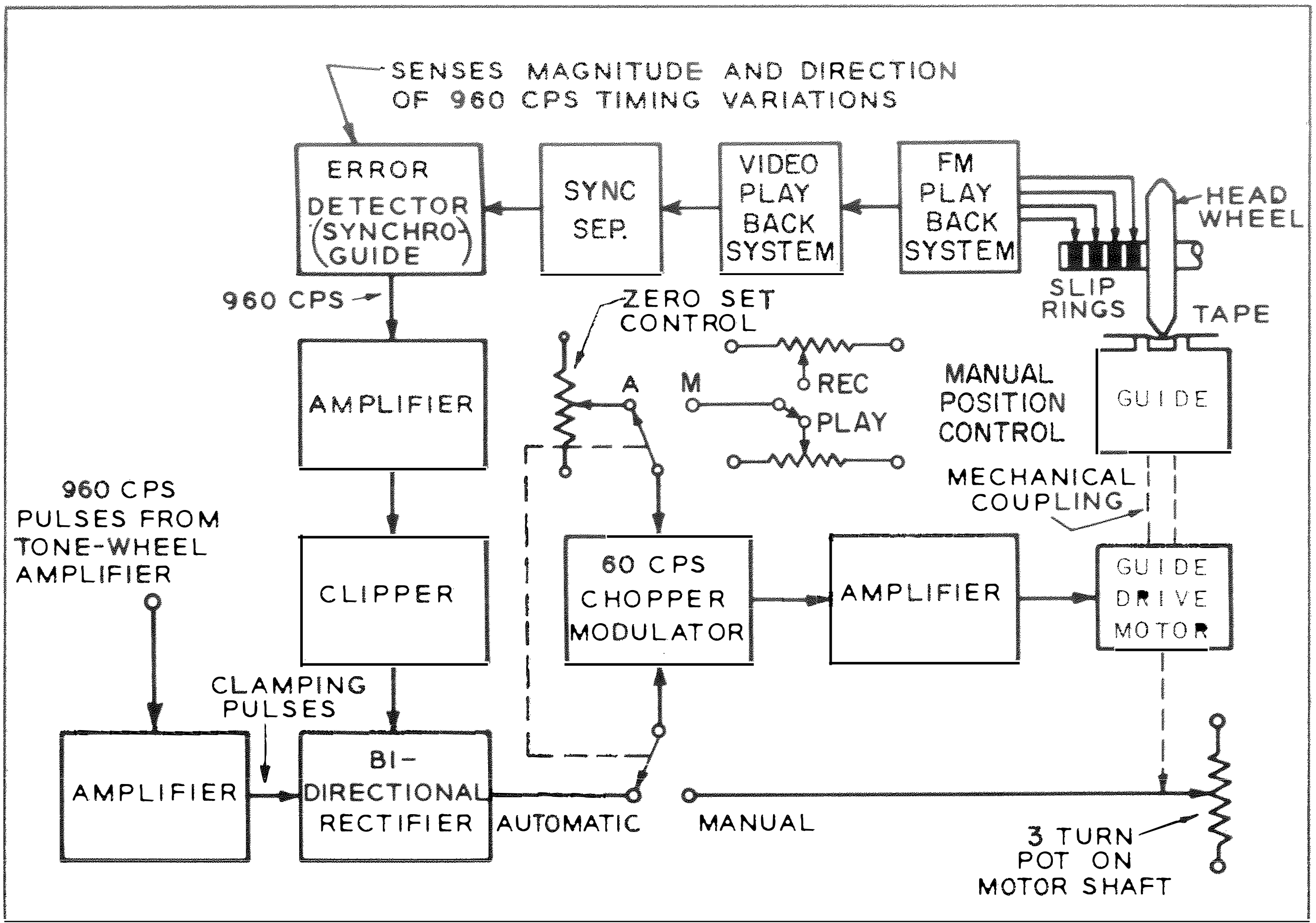


Figure VGS-5. Simplified Block Diagram of Guide Servo System

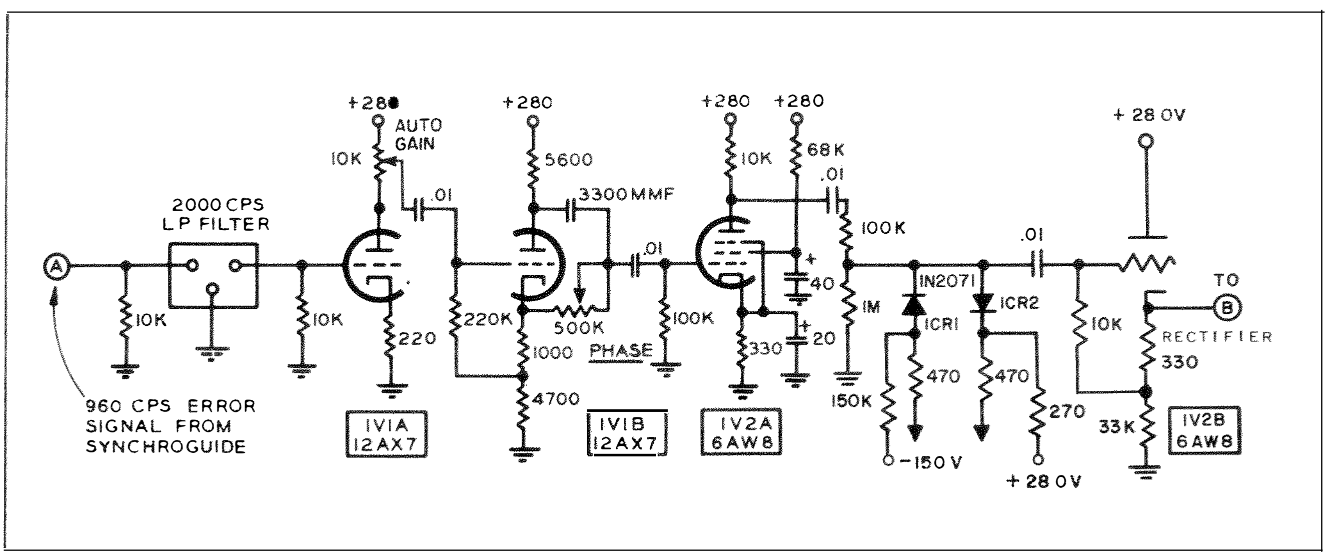


Figure VGS-6. 960 cps Error Signal Amplifier

shifter in the output side of stage 1V1B makes it possihle to adjust the peaks (or the valleys) of the 960 cps error signal to coincide with the 960 cps tone-wheel pulses used for clamping purposes in the bi-directional rectifier to be discussed presently. Further amplification occurs in stage 1V2A, the output of which feeds the clipper circuit that is used to limit excessive error signals.

The clipping action of diodes 1CR1 and 1CR2 limit the 960 cps signal to a maximum peak-to-peak swing of about 1 volt. When either diode conducts, the signal is sharply attenuated by the 100K (1R26) resistor in series with the low forward impedance of the diode. The clipped signal is fed to the cathode follower stage (1V2B) which provides a low impedance drive for the clamp-type rectifier.

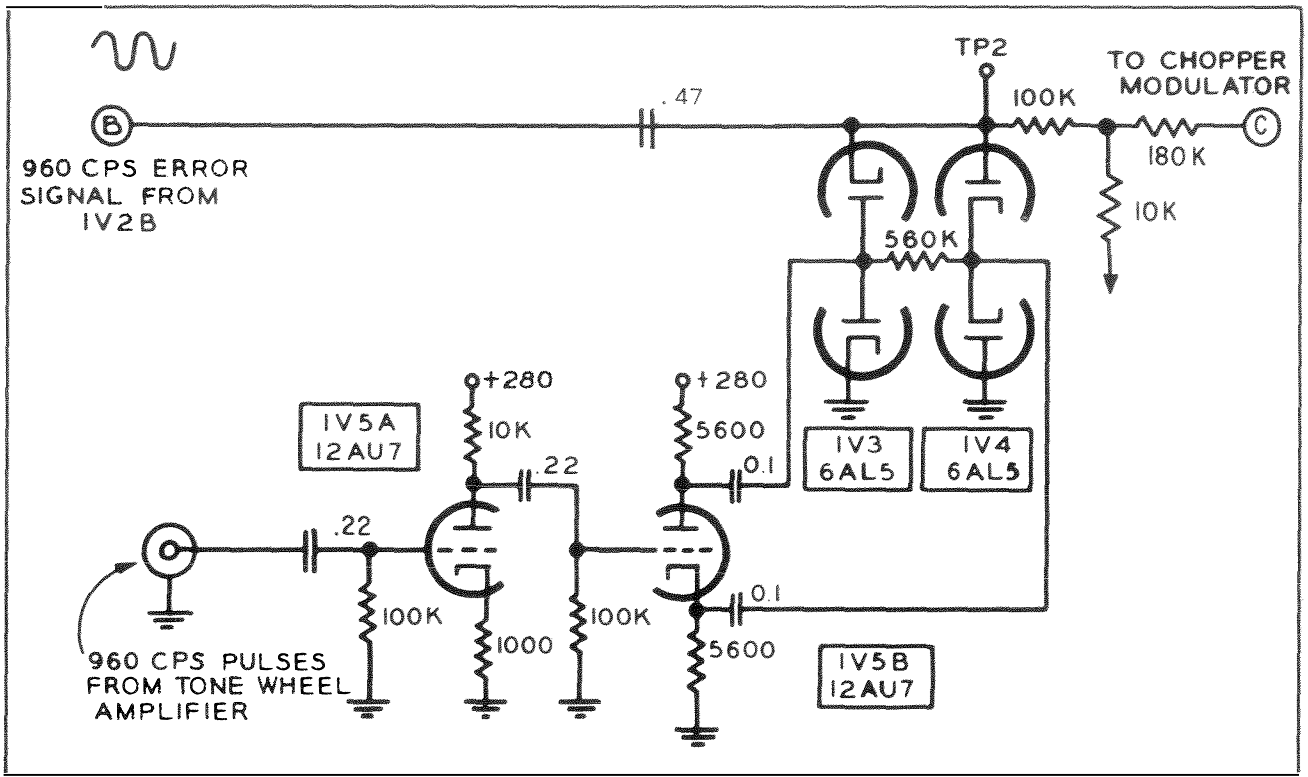


Figure VGS-7. Error Signal Rectifier

Error Signal Rectifier—Figure VGS-7 shows the bi-directional error signal rectifier and the clamping cicuits closely related to it. The 960 cps error signal from the cathode of stage 1V2B is clamped by stages 1V3 and1V4, which are keyed by tonewheel pulses introduced through stages 1V5A (voltage amplifier) and 1V5B (phase splitter). Diodes 1V3 and 1V4 are connected in a bridge circuit and remain open except during tonewheel pulse intervals. When the diodes conduct, the right side of the .47 mf capacitor is tied through a low impedance to ground. Whether the clamping pulses occur during the positive or negative half-cycle of the error signal depends upon the polarity of the 960 cps signal from the synchroguide, which in turn depends upon the direction of the timing errors. The smoothed dc voltage, at the output of the integrator network consisting of voltage divider network 1R15, 1R64, series resistor 1R65 and capacitor 2C13, is therefore either plus or minus depending upon the direction in which the guide must be moved to eliminate the error. When the guide position is correct both the 960 cps error signal and the rectified signal go to zero.

Modulator and Motor Drive Circuits—To avoid the stability problems frequently associated with high gain d-c amplifiers, the rectified signal is converted to a 60 cps by 2G1, a chopper modulator driven from the power line through a 6.3 volt winding on the power transformer (see figure VGS-8). In the AUTOMATIC mode, the chopper develops an output signal only if there is a difference between the error signal and the voltage developed across the control marked ZERO SET; the latter control is used only to cancel out any small voltage offset in the error signal that may result from hum pickup or slight unbalance in the clamp-type rectifier. In the MANUAL operating

condition (used in the record mode) the chopper develops an output signal whenever the setting of the manual GUIDE POSITION control does not coincide with the setting of a potentiometer directly coupled to the motor shaft. A capacitor (.003 μf) at the output of transformer 2T2 suppresses most of the harmonics of the 60 cps signal generated by the chopper.

Three stages of voltage amplification are provided by 2V4 and 2V3A. Stage 2V3B functions as a rectifier to provide B+ power for the voltage amplifier; B+ decoupling is provided between the voltage amplifier stages. The built-in power supply for the circuits in the power amplifier subassembly is interlocked with the B+ power supply of the other circuits on the shoe servo chassis by means of relay 1K5.

The guide drive motor is a two-phase type in which one phase is driven directly from the power line through a 1.0 mf phase-shifting capacitor, and the other phase is driven by the 60 cps voltage at the output of a pair of controlled rectifiers, 2V1 and 2V2. If there is no error signal on the grids of these tubes, there will be no 60 cps component in the output. The dc component is prevented from flowing through the motor winding by a 50 mf blocking capacitor, and the 15 henry choke provides a dc current path. If an error signal is present, however, the 60 cps grid signal is in phase with the plate voltage pulse on one side of the circuit and out of phase with the plate voltage pulse on the other side. (Proper phase relationships between plate and grid circuits are assured by the fact that the phase lag introduced by the chopper is compensated by the phase lead introduced by the interstage coupling networks in the voltage amplifier.) The net result is that one half-cycle is amplified more than the other in the controlled rectifier and a 60 cps component appears at the output. Filtering to emphasize this 60 cps component and to suppress the higher harmonics is provided both by the 1.0 mf filter capacitor between the center tap of the transformer and the common cathode circuit, and by the 0.47 mf capacitor which resonates the parallel combination of the motor windings and the 15 henry choke at 60 cps. Torque is produced by the motor only when a 60 cycle signal is delivered by the controlled rectifier, and the direction of this torque depends upon the phase or polarity of the 60 cycle signal. A small amount of positive current feedback is coupled from the cathode circuit of 2V1 and 2V2 to the cathode of 2V3A to provide velocity damping for the motor.

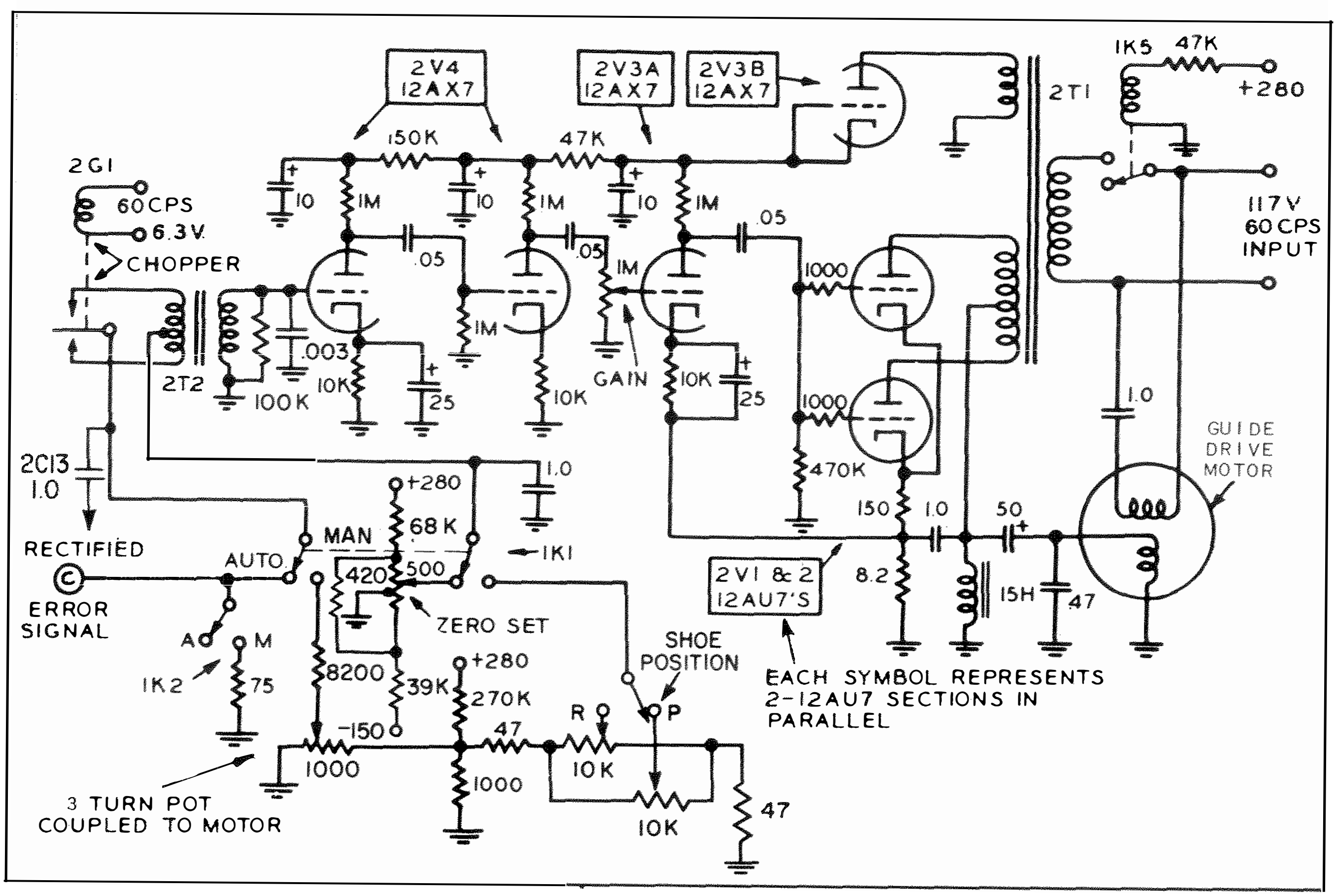


Figure VGS-8. Modulator and Motor Drive Circuits

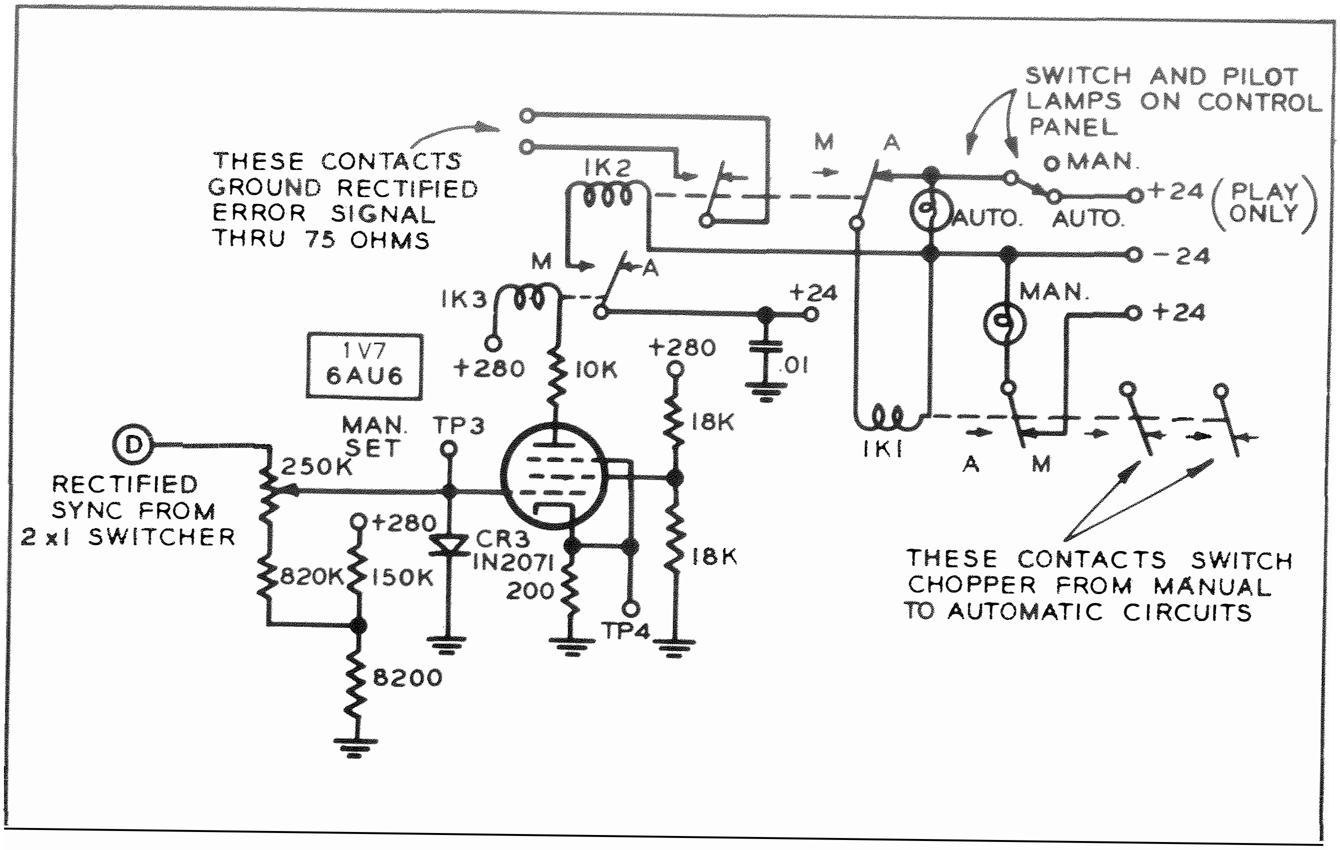


Figure VGS-9. Control Circuits

Control Circuits—Both the manual and automatic control circuits for the vacuum guide servo system are shown in figure VGS-9. The MANUAL-AUTOMATIC switch on the control panel controls the input to the chopper modulator through relay 1K1. Automatic operation is possible only in the playback mode, since the +24 volt source to operate 1K1 is interlocked with the PLAY pushbutton, but the switch may be left in the AUTOMATIC position so that the machine is always ready for proper playback upon pushing the PLAY button.

Two guide position controls for manual operation are provided on the control panel. One, controlled by the RECORD control is used in the record mode only. The second control, operated by the PLAY control is used for playback only. The guide position can thus be adjusted manually in the play mode without disturbing the desired pressure for recording. Tube 1V6 is a control tube to disable the shoe servo system when the signal at the output of the video playback system drops below a predetermined level and becomes sufficiently noisy that the operation of the shoe servo system is less reliable than manual operation. Tube 1V6 is normally held in a cut-off condition by rectified sync pulses derived from the sync separator on the 2 x 1 switch chassis. The sync pulses before rectification are negative-going and provide enough negative voltage to override the positive bias applied through the MANUAL SET control (potentiometer). If the signal level drops ahead of the sync separator, the negative voltage developed by rectifying the sync pulses also drops and permits tube 1V6 to conduct, thus closing relay 1K3, which in turn closes 1K2 and opens 1K1. Diode CR3 limits the voltage on the grid of 1V6 to nominally ground potential.

NOTE: When the action of tube 1V7 has automatically switched the circuit over to the manual condition, both pilot lamps are illuminated when the MANUAL-AUTOMATIC switch is in the AUTOMATIC position. The illumination of both pilot lamps therefore serves as a visual indication that the sync level has dropped below the predetermined threshold level, and that manual setting of the vacuum guide is desirable.

MAINTENANCE

Improper operation of the vacuum guide servo is due in most instances to weak or defective tubes. Tubes must be replaced with the exact types specified.

Setup Procedure

Before making any adjustments on the vacuum guide servo, thread a pre-recorded tape (preferably one containing vertical bars) on to the recorder and be sure that the recorder is set up for normal playback. The setup procedure to be used is as follows:

1. Set the following vacuum guide controls as follows:
    a. MAN-SET (1R30) fully clockwise (leave the control in this position permanently).
    b. ZERO SET (1R53) in mid-position.
    c. GAIN (2R8) in mid-position.
    d. AUTO GAIN (1R64) fully counterclockwise.
    e. PHASE (1R7) fully clockwise.

2. Connect an oscilloscope (Tektronix Model 535 or equivalent) to the test point labeled 960 TW IN (TP5) on the vacuum guide servo chassis.

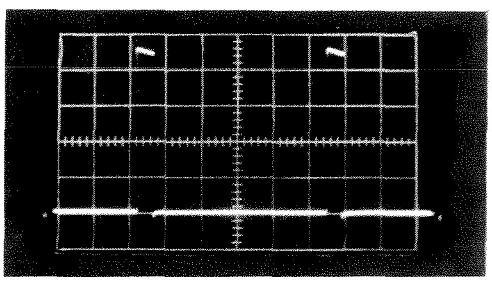
3. Press the control panel STANDBY button. The waveform on the oscilloscope should appear as in figure VGS-10A.

4. Place the control panel GUIDE POSITION switch in the MANUAL position.

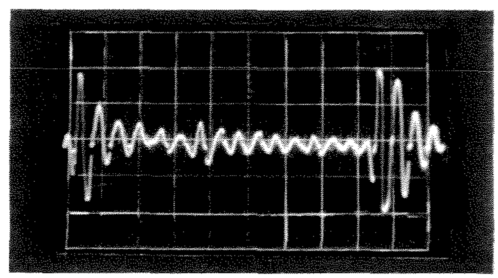
5. Press the control panel PLAY button, and the MONITOR LINE OUT button on the CRO/Monitor switcher. Turn the control panel PLAY GUIDE POSITION control back and forth and observe the picture monitor (unit 103) to see if the control is effective. (Jogs should appear and disappear as the control is turned.) If no action is obtained turn the vacuum guide servo GAIN control (2R8) slightly clockwise, and again check the action of the PLAY GUIDE POSITION control. Continue this procedure until action (jogs) is obtained.

6. Turn the PLAY GUIDE POSITION control to position 1 on the DECREASE side of the scale. One-mil "jogs", sloping downward from right to left, should then appear (since this position of the control causes a 1-mil error in the guide position in the direction of decreased pressure).

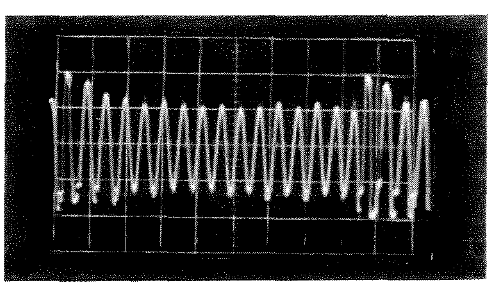
7. Place the GUIDE POSITION switch in the AUTOMATIC position, and increase AUTO GAIN until action is obtained.



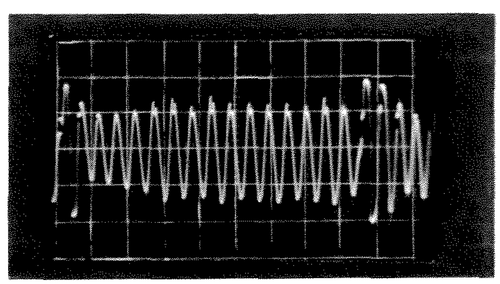
A. 960 T.W. IN (TP-5)
Sweep Rate: 200 μsec/cm
Amplitude: 1-0 volt/cm



C. BRIDGE (TP-2)
Zero Set Control Too Low
Sweep Rate: 2000 μsec/cm
Amplitude: 0.5 volt/cm



B. BRIDGE (TP-2)
Zero Set Control Normal
Sweep Rate: 2000 μsec/cm
Amplitude: 0.5 volt/cm



D. BRIDGE (TP-2)
Zero Set Control Too High
Sweep Rate: 2000 μsec/cm
Amplitude: 0.5 volt/cm

Figure VGS-10. Waveforms for Use with Setup Procedure

8. Adjust the ZERO SET control until the jogs are eliminated. If the jogs go through zero and the control is difficult to adjust turn the PHASE GAIN control fully counterclockwise and then readjust the ZERO SET control.

NOTE: If the servo rack is located too far from the picture monitor to permit observing the picture, connect an oscilloscope to the test point labeled BRIDGE (TP2) on the guide servo and make the adjustments while observing the oscilloscope. Figures VGS-10B, C, and D, show the waveforms when the ZERO SET control (1R53) is set correctly, too high, or too low.

9. Turn the AUTO GAIN slightly clockwise, and then switch the control panel AUTOMATIC-MANUAL switch from AUTOMATIC to MANUAL to AUTOMATIC, and observe the speed at which the jogs disappear. Repeat the procedure until desired speed is obtained.

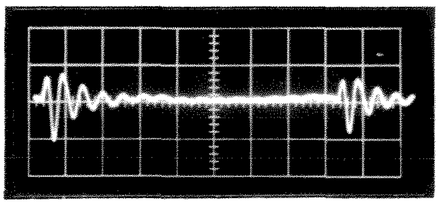
NOTE: If the AUTO GAIN control is set too high the servo system will overshoot or hunt.

10. If the speed of response is too slow and hunting does not occur, even the AUTO GAIN control is fully clockwise, turn the manual GAIN control (2R8) slightly clockwise and repeat step 9.

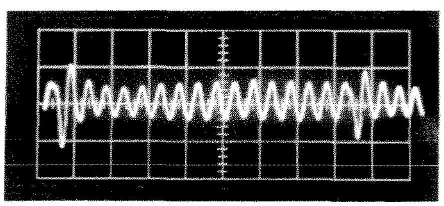
Waveforms and Voltages Check

Figures VGS-11 through VGS-13 show typical waveforms obtained throughout the unit for use as an aid in troubleshooting. All waveforms were obtained with a Tektronix Type 535A oscilloscope having a 10:1 attenuator probe and with the tape recorder in SETUP.

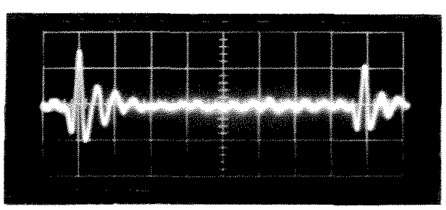
The voltage table adjacent to the schematic diagram (figure VGS-15) indicates typical tube socket voltages taken with respect to chassis ground, and were measured with a vacuum-tube voltmeter (VTVM). All voltages are dc unless otherwise noted.



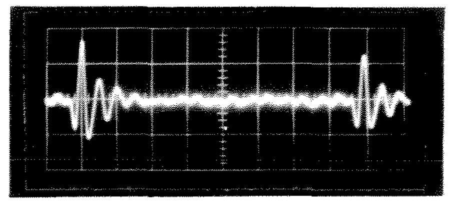
A. Test Point TP-1
Sweep Rate: 2000 μsec/cm
Amplitude: 0.05 volt/cm
Error: 0 jog



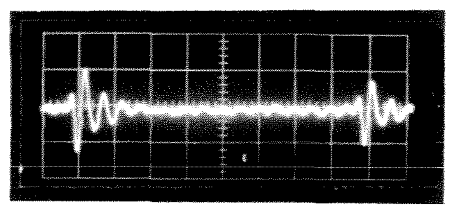
B. Test Point TP-1
Sweep Rate: 2000 μsec/cm
Amplitude: 0.05 volt/cm
Error: ½ mill. jog



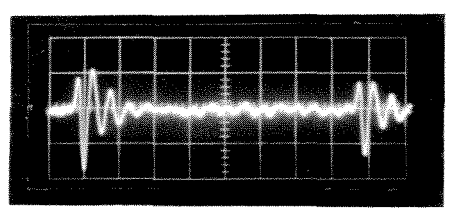
C. 1V1 Plate (pin 1)
Sweep Rate: 2000 μsec/cm
Amplitude: 0.5 volt/cm
Error: 0 jog



D. 1V1 Cathode (pin 8)
Sweep Rate: 2000 μsec/cm
Amplitude: 0.05 volt/cm
GUIDE POSITION switch: AUTOMATIC
Error: 0 jog

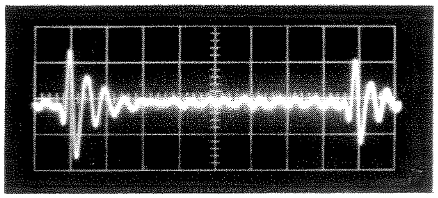


E. 1V1 Plate (pin 6)
Sweep Rate: 2000 μsec/cm
Amplitude: 0.05 volt/cm
Error: 0 jog

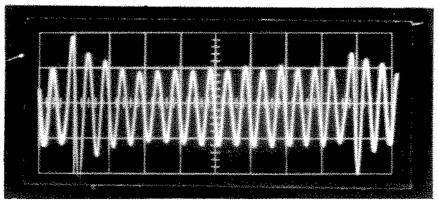


F. 1V2 Grid (pin 7)
Sweep Rate: 2000 μsec/cm
Amplitude: 0.05 volt/cm
Error: 0 jog

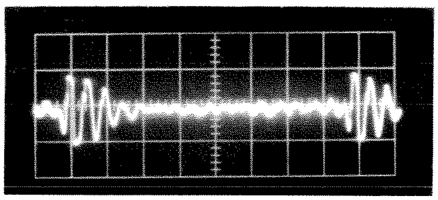
Figure VGS-11. Typical Waveforms



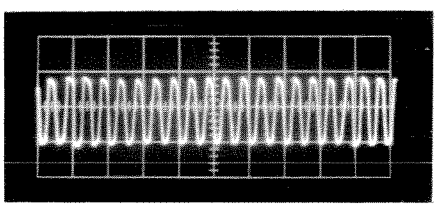
A. 1V2 Plate (pin 9)
Sweep Rate: 2000 μsec/cm
Amplitude: 2 volts/cm
Error: 0 jog



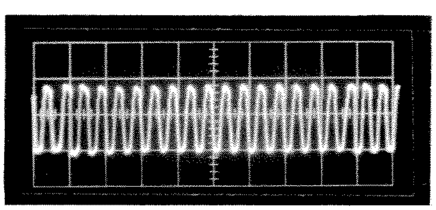
B. 1V2 Plate (pin 9)
Sweep Rate: 2000 μsec/cm
Amplitude: 2 volts/cm
Error: ½ mill. jog



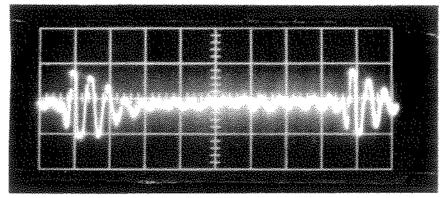
C. 1V2 Grid (pin 2)
Sweep Rate: 2000 μsec/cm
Amplitude: 1 volt/cm
Error: 0 jog



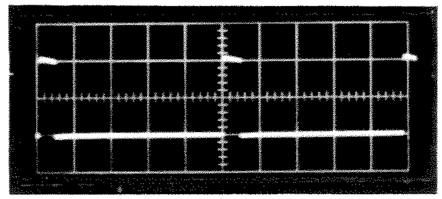
D. 1V2 Grid (pin 2)
Sweep Rate: 2000 μsec/cm
Amplitude: 1 volt/cm
Error: ½ mill. jog



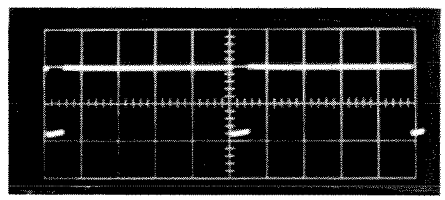
E. Test Point BRIDGE (TP-2)
Sweep Rate: 2000 μsec/cm
Amplitude: 1 volt/cm
Error: ½ mill. jog



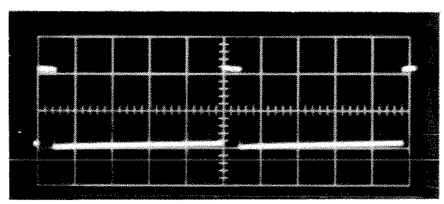
F. Test Point BRIDGE (TP-2)
Sweep Rate: 2000 μsec/cm
Amplitude: 1 volt/cm
Error: 0 jog



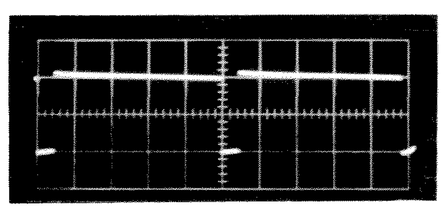
G. 1V5 Grid (pin 2)
Sweep Rate: 200 μsec/cm
Amplitude: 2 volts/cm



H. 1V5 Plate (pin 1)
Sweep Rate: 200 μsec/cm
Amplitude: 10 volts/cm

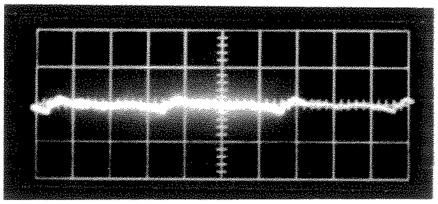


I. 1V3 Plate (pin 2)
Sweep Rate: 200 μsec/cm
Amplitude: 5 volts/cm

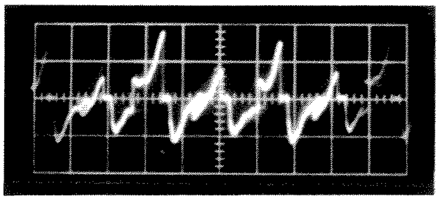


J. 1V4 Cathode (pin 2)
Sweep Rate: 200 μsec/cm
Amplitude: 5 volts/cm

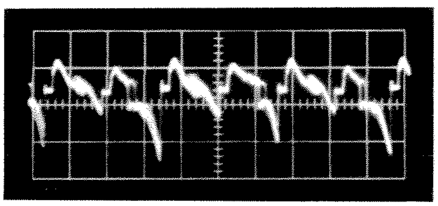
Figure VGS-12. Typical Waveforms



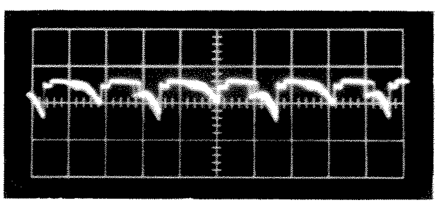
A. 2V4 Grid (pin 2)
Sweep Rate: 5000 μsec/cm
Amplitude: 0.05 volt/cm



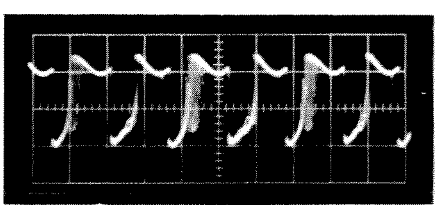
B. 2V4 Plate (pin 1)
Sweep Rate: 5000 μsec/cm
Amplitude: 0.2 volt/cm



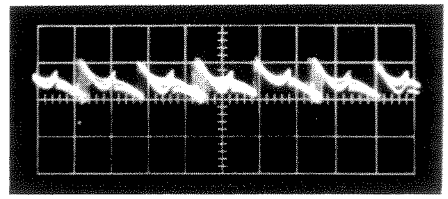
C. 2V4 Plate (pin 6)
Sweep Rate: 5000 μsec/cm
Amplitude: 20 volts/cm



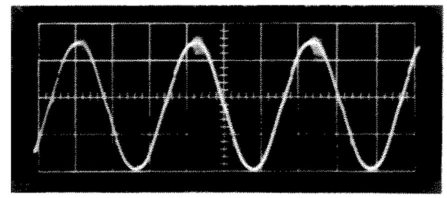
D. 2V4 Grid (pin 2)
Sweep Rate: 5000 μsec/cm
Amplitude: 20 volts/cm



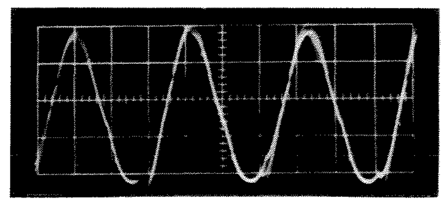
E. 2V3 Plate (pin 1)
Sweep Rate: 5000 μsec/cm
Amplitude: 50 volts/cm



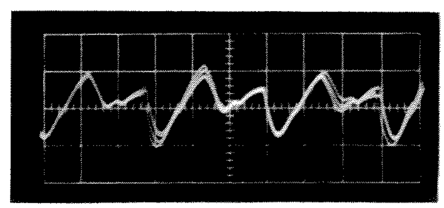
F. 2V3 Cathode (pin 3)
Sweep Rate: 5000 μsec/cm
Amplitude: 0.5 volt/cm



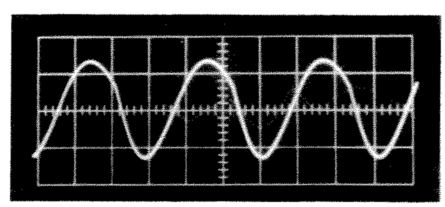
G. 2V3 Plate (pin 6)
Sweep Rate: 5000 μsec/cm
Amplitude: 200 volts/cm



H. 2V1 Plate (pin 1)
Sweep Rate: 5000 μsec/cm
Amplitude: 200 volts/cm



I. Terminal Board 1TB1-5
Sweep Rate: 5000 μsec/cm
Amplitude: 100 volts/cm
GUIDE POSITION switch:
AUTOMATIC



J. Terminal Board 1TB1-5
Sweep Rate: 5000 μsec/cm
Amplitude: 200 volts/cm
GUIDE POSITION switch:
MANUAL (motor running)

Figure VGS-13. Typical Waveforms

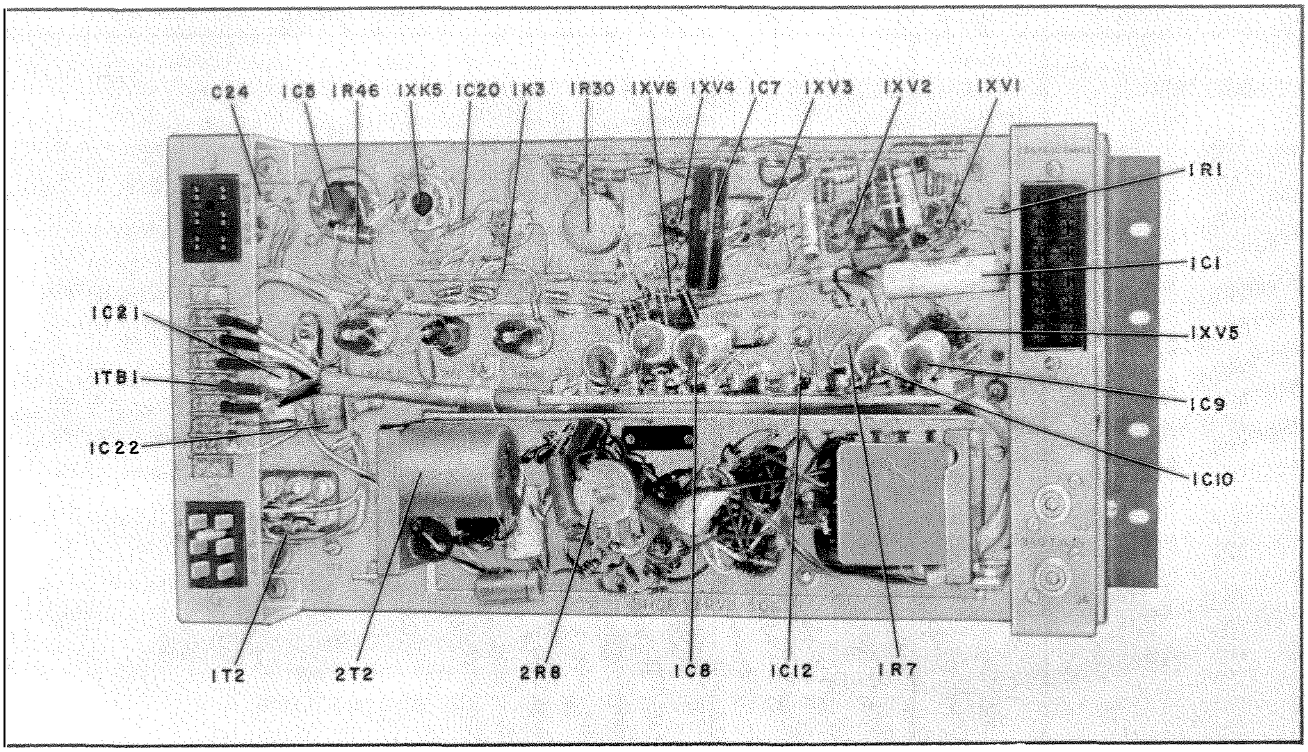


Figure VGS-14. Vacuum Guide Servo (Rear View)

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			SHOE SERVO (8979132-501)
			CAPACITORS:
1C1	95624	737818-96	paper, 0.47 μf ±10%, 400 v
1C2			Not Used
1C3		727876-259	mica, 3300 μμf ±5%, 500 v char "B"
1C4		735715-163	paper, 0.01 μf ±10%, 400 v
1C5A/C	97479	442900-76	electrolytic, 40/40/20 μf, 450/450/25 v
1C6		735715-163	paper, 0.01 μf ±10%, 400 v
1C7	95624	737818-96	paper, 0.47 μf ±10%, 400 v
1C8			Not Used
1C9, 1C10		735715-179	paper, 0.22 μf ±10%, 400 v
1C11		735715-175	paper, 0.1 μf ±10%, 400 v
1C12		735715-75	paper, 0.1 μf ±10%, 200 v
1C13 to 1C15			Not Used
1C16, 1C17		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
1C18, 1C19		735715-179	paper, 0.22 μf ±10%, 400 v
1C20		8811182-5	ceramic, 10,000 μμf +100 -20%, 450 v
1C21	218485	8941243-24	electrolytic, 50 μf, 25 v
1C22	217061	737818-56	paper, 0.47 μf ±10%, 200 v
1C23		735715-71	paper, 0.047 μf ±10%, 200 v
1C24	59983	95695-75	electrolytic, 40 μf, 450 v
1CR1 to 1CR3	219245		Diode: Type 1N2071
1DS1, 1DS2	101857	872291-9	Lamp: indicator NE51
1F1	98682	990157-109	Fuse: 1.5 amp, 125 v, slo-blo
1FL1	219244	8440178-1	Filter: low pass
1J1	53140	727969-15	Connector: female, 12 contact, chassis mtg.
1J2			Not Used
1J3, 1J4	51800	255223-2	Connector: coax, chassis mtg.

Symbol No.	Stock No.	Drawing No.	Description
1J5	51594	727969-1	Connector: female, 6 contact, chassis mtg.
1J6	51604	727969-3	Connector: male, 6 contact chassis mtg.
1K1	218223	460355-6	Relay: 24 v, 3 PDT
1K2	206744	460355-2	Relay: 24 v, DPDT
1K3	99155	8817527-1	Relay: SPDT
1K4			Not Used
1K5	215302	460355-5	Relay: 50 v, DPDT
1L1	216951	8440105-1	Reactor: filter, 15 henry
1P1	54253	727969-16	Connector: male, 12 contact
1P2			Not Used
1P3			Connector: coax, cable mtg.
	215661	252868-1	Connector only
	54246	893648-2	Adapter only: solder type
1P4	215661	252868-1	Connector: coax, cable mtg.
1P5	51595	727969-2	Connector: male, 6 contact
1P6	51607	727969-4	Connector: female, 6 contact
			RESISTORS:
			Fixed, Composition - unless otherwise specified
1R1		82283-74	10,000 ohm ±10%, ½ w
1R2		82283-54	220 ohm ±10%, ½ w
1R3		82283-90	220,000 ohm ±10%, ½ w
1R4		82283-70	4700 ohm ±10%, ½ w
1R5		82283-62	1000 ohm ±10%, ½ w
1R6		82283-71	5600 ohm ±10%, ½ w
1R7	97961	8971860-117	variable, comp., 500,000 ohm ±10%, 2 w
1R8		82283-86	100,000 ohm ±10%, ½ w
1R9		82283-56	330 ohm ±10%, ½ w
1R10		99126-80	33,000 ohm ±10%, 2 w
1R11		82283-84	68,000 ohm ±10%, ½ w
1R12		82283-98	1 meg ±10%, ½ w
1R13		99126-74	10,000 ohm ±10%, 2 w
1R14		82283-95	560,000 ohm ±10%, ½ w
1R15, 1R16		82283-86	100,000 ohm ±10%, ½ w
1R17		82283-74	10,000 ohm ±10%, ½ w
1R18		82283-62	1000 ohm ±10%, ½ w
1R19		82283-86	100,000 ohm ±10%, ½ w
1R20, 1R21		82283-71	5600 ohm ±10%, ½ w
1R22		82283-151	470 ohm ±5%, ½ w
1R23		82283-74	10,000 ohm ±10%, ½ w
1R24			Not Used
1R25		82283-211	150,000 ohm ±5%, ½ w
1R26		82283-86	100,000 ohm ±10%, ½ w
1R27		82283-217	270,000 ohm ±5%, ½ w
1R28		82283-151	470 ohm ±5%, ½ w
1R29			Not Used
1R30	57402	8971860-116	variable, comp., 250,000 ohm ±10%, 2 w
1R31			Not Used
1R32		90496-142	200 ohm ±5%, 1 w
1R33, 1R34		90496-77	18,000 ohm ±10%, 1 w
1R35 to 1R37			Not Used
1R38		82283-91	270,000 ohm ±10%, ½ w
1R39		82283-62	1000 ohm ±10%, ½ w
1R40		82283-111	10 ohm ±5%, ½ w
1R41			Part of XDS1 (56,000)
1R42		82283-73	8200 ohm ±10%, ½ w
1R43		82283-132	75 ohm ±5%, ½ w
1R44, 1R45		82283-46	47 ohm ±10%, ½ w
1R46		99126-82	47,000 ohm ±10%, 2 w
1R47		82283-56	330 ohm ±10%, ½ w
1R48		82283-94	470,000 ohm ±10%, ½ w
1R49, 1R50			Not Used
1R51		90496-74	10,000 ohm ±10%, 1 w
1R52		90496-81	39,000 ohm ±10%, 1 w
1R53	219246	433196-106	variable, comp., 500 ohm ±20%, ½ w (center tapped)

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
1R54		99126-84	68,000 ohm ±10%, 2 w
1R55			Part of XDS2 (56,000)
1R56		82823-111	10 ohm ±5%, ½ w
1R57		82283-87	120,000 ohm ±10%, ½ w
1R58, 1R59		82283-74	10,000 ohm ±10%, ½ w
1R60		90496-88	150,000 ohm ±10%, 1 w
1R61		82283-181	8200 ohm ±5%, ½ w
1R62		82283-97	820,000 ohm ±10%, ½ w
1R63		82283-94	470,000 ohm ±10%, ½ w
1R64	93175	8971860-110	variable, 10,000 ohms ±10%, 2 w
1R65		82283-89	180,000 ohms ±10%, ½ w
1R66		82283-58	470 ohms ±10%, ½ w
1T1			Not Used
1T2	57021	949069-1	Transformer: filament
1TP1 to 1TP5	208983	8825493-7	Connector: jack, yellow
XDS1, XDS2	208458	990789-5	Socket: indicator light
XF1	48894	99088-2	Holder: fuse
1XK1	9915	746008-8	Socket: relay, 11 pin
1XK2	68590	99100-4	Socket: relay, 8 pin
1XK3	94925	737867-14	Socket: relay, 7 pin
1XK4			Not Used
1XK5	68590	99100-4	Socket: relay, 8 pin
1XV1, 1XV2	94926	737870-14	Socket: tube, 9 pin
1XV3, 1XV4	94925	737867-14	Socket: tube, 7 pin
1XV5	94926	737870-14	Socket: tube, 9 pin
1XV6	94925	737867-14	Socket: tube, 7 pin
2A1		8437850-1	Amplifier: servo
			CAPACITORS:
2C1			paper, 0.003 μf, 400 v
2C2	96420		electrolytic, 10 μf, 450 v
2C3, 2C4	59928		electrolytic, 25 μf, 25 v
2C5			paper, 0.047 μf, 400 v
2C6	96420		electrolytic, 10 μf, 450 v
2C7			paper, 0.047 μf, 400 v
2C8	96420		electrolytic, 10 μf, 450 v
2C9	59928		electrolytic, 25 μf, 25 v
2C10			paper, 0.047 μf, 400 v
2C11, 2C12	210613		paper, 1.0/1.0 μf, 330 v AC
2C13	56694		paper, 1 μf, 200 v
2F1	212327		Fuse: ½ amp, 250 v, 3 AG, slo-blo
2G1	218953	8437889-1	Converter: 6.3 v, coil
			RESISTORS:
			Fixed, Composition - unless otherwise specified
2R1			22,000 ohm ±10%, ½ w
2R2			1 meg ohm ±10%, ½ w
2R3			150,000 ohm ±10%, ½ w
2R4			10,000 ohm ±10%, ½ w
2R5, 2R6			1 meg ohm ±10%, ½ w
2R7			47,000 ohm ±10%, ½ w
2R8	92231		variable, gain control, 1 meg ohm ½ w
2R9			10,000 ohm ±10%, ½ w
2R10			1 meg ohm ±10%, ½ w
2R11			470,000 ohm ±10%, ½ w
2R12	219354		wire wound, 150 ohm ±5%, 1 w
2R13	210535		wire wound, 8.2 ohm ±5%, ½ w
2R14, 2R15			2.2 meg ±10%, ½ w
2R16 to 2R19			1000 ohm ±10%, ½ w
2R20			100,000 ohm ±10%, ½ w
2R21			150,000 ohm ±10%, ½ w
2T1	210587		Transformer: power
2T2	219353		Transformer: input

Symbol No.	Stock No.	Drawing No.	Description
			Miscellaneous:
	48894		Holder: fuse
	208080	990788-507	Jewel: clear plastic
	56359		Shield: tube

VOLTAGE TABLE

Tube Symbol	Tube Type	Tube Pin Numbers								
		1	2	3	4	5	6	7	8	9
1V1	12AX7	242	0	.8	6.3 ac	6.3 ac	270	7.4	9.5	6.3 ac
1V2	6AW8	115	111	280	6.3 ac	6.3 ac	3.4	0	140	200
1V3	6AL5	0	—11	6.3 ac	6.3 ac	0	NC	—11	—	—
1V4	6AL5	10	0	6.3 ac	6.3 ac	10	NC	0	—	—
1V5	12AU7	215	0	7	6.3 ac	6.3 ac	270	0	14.2	6.3 ac
1V6	6AU6	—6.5	0	6.3 ac	6.3 ac	280	145	0	—	—
2V1	12AU7	—20	—20	7	6.3 ac	6.3 ac	—20	—20	7	6.3 ac
2V2	12AU7	—20	—20	7	6.3 ac	6.3 ac	—20	—20	7	6.3 ac
2V3	12AX7	70	—1	2	*6.3 ac	*6.3 ac	—	—	225	*6.3 ac
2V4	12AX7	120	—.1	1.5	6.3 ac	6.3 ac	105	—.1	1.8	6.3 ac

*225 volts D.C.

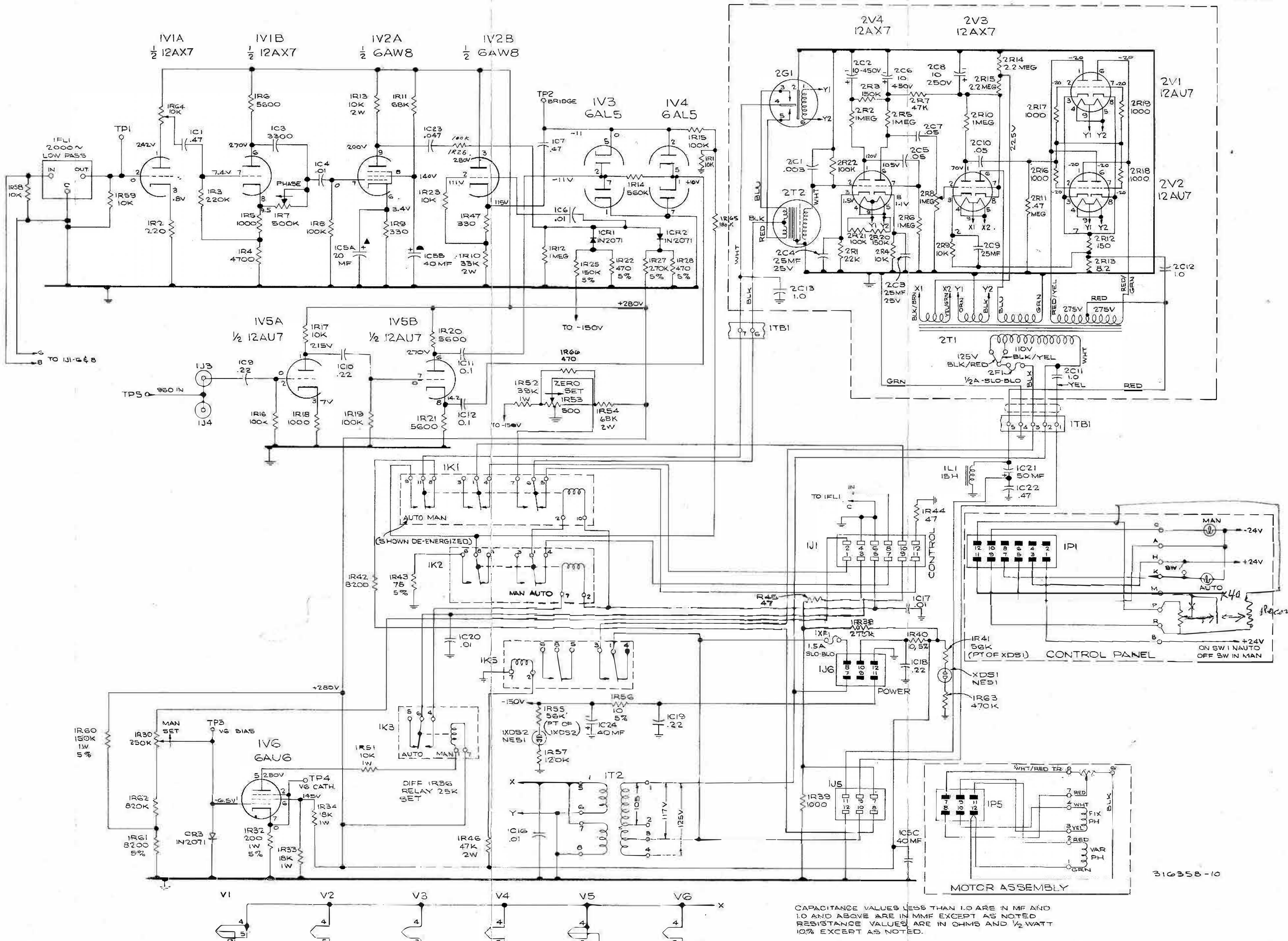


Figure VGS-15. Vacuum Guide Servo Schematic Diagram

24 Volt Regulated Power Supply

UNIT 507

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
DU 641

IB-31154

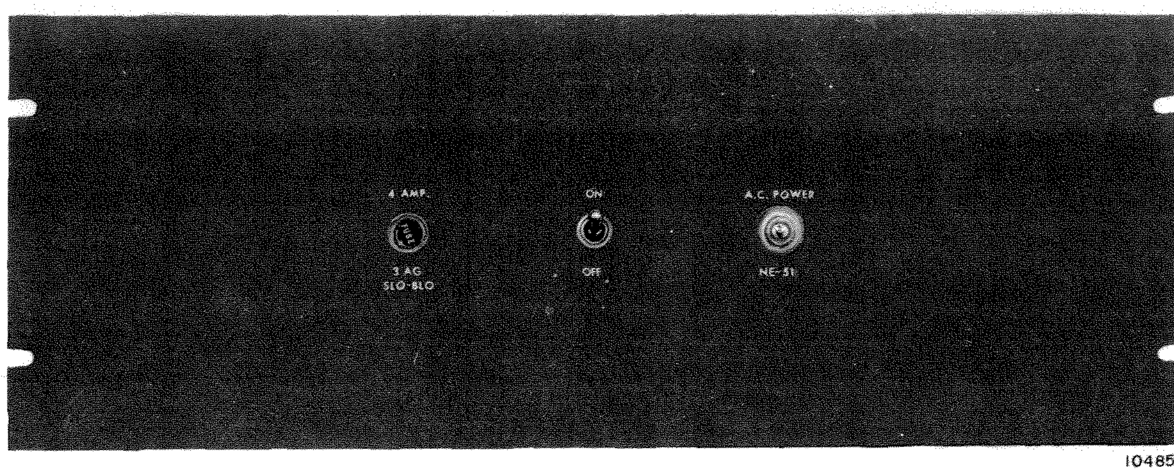


Figure RPS-1. 24-Volt Power Supply

TECHNICAL DATA

Power

AC Input:	100/130 volts, 250 watts (From Circuit Breaker H5)
DC Output:	24.5 ±0.5 volts, 7.5 amps. (Nominal)
Ripple:	20 millivolts peak-to-peak

Fuse

4 ampere, type 3AG Slo-Blo

DESCRIPTION

The 24-Volt Power Supply, unit 507 located near the bottom of rack #5, delivers 24.5 volts dc to energize the relays of the control relay bank, and other chassis throughout the tape recorder; also it is used to actuate the brake solenoids on the rear of the tape transport panel. There are two versions of the power supply available: one for 60 cycle operation (8721830-1), and one for 50 cycle operation (8726843-1).

The power supply is protected by a four-ampere slo-blo fuse in series with the primary winding of the power transformer T1. A lamp, DS1, connected in parallel with the power transformer primary winding indicates when power is applied (switch SW1 closed).

An input voltage between 100 and 130 volts ac applied to terminals 1 and 2 of terminal board TB1 will give a dc output voltage as measured at terminals 5 (−) and 6 (+) of terminal board TB1. With an input voltage of 117 volts, the output voltage will vary between 24.1 and 26.1 volts as the load varies between full load (10 amperes) and no load. With a fixed load of 10 amperes, the output voltage will remain within ±0.3 volt as the input voltage varies between 100 and 130 volts. (Nominal load current in the record mode of operation is 8 amps.) The 24 volt power supply is provided with a ground point on the positive side (terminal 4).

Circuit

The output of transformer T1 is applied to silicon rectifiers CR1 and CR2 where it is converted from an alternating current to a direct current. The output of rectifiers CR1 and CR2 is applied to a filter network of four 25,000 microfarad electrolytic capacitors in parallel; their reactance at a ripple frequency of 100 or 120 cycles is very low. A bleeder resistor of 75 ohms, 40 watts is connected across the output of the filter to limit the maximum no-load voltage.

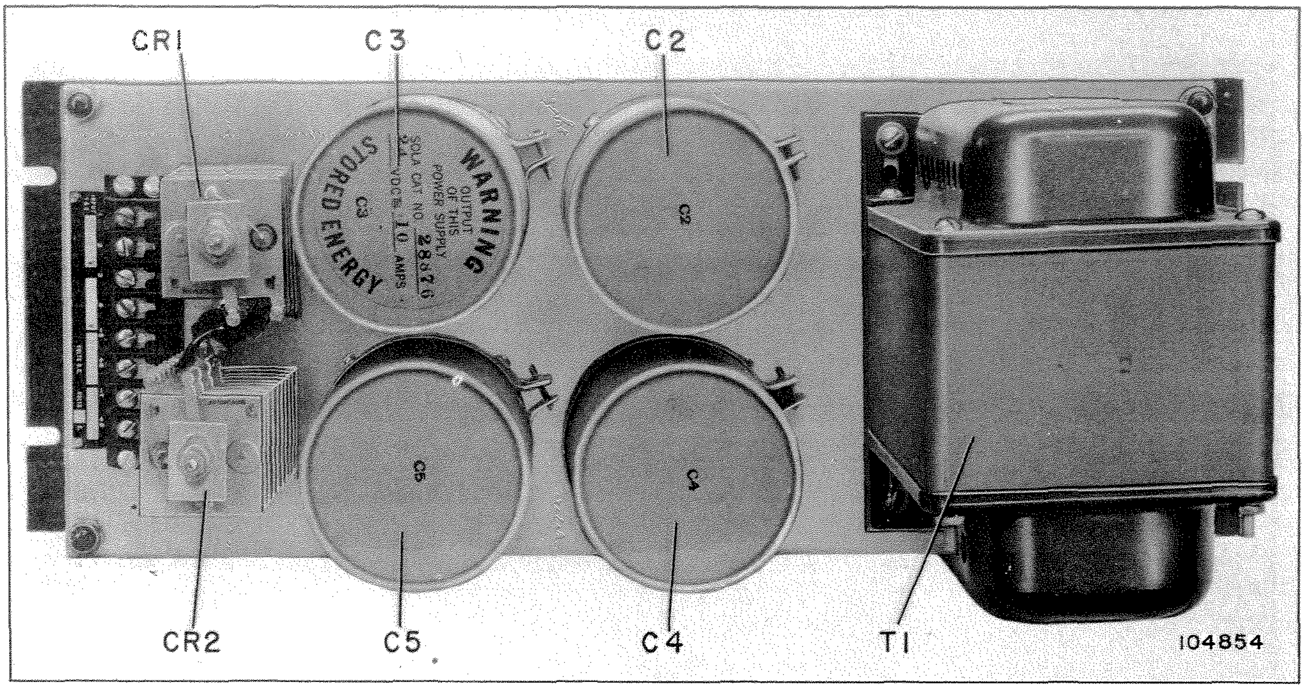


Figure RPS-2. 24-Volt Power Supply, Rear View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			24 V REGULATED POWER SUPPLY, 60 CYCLE
C1	219440		Capacitor: paper, 5 μf, 660 v ac
C2 to C5	219439		Capacitor: electrolytic, 25,000 μf, 25 v
CR1, CR2	219438		Rectifier: silicon
DS1			Light: indicator
	208163		Socket only
	208080		Jewel only
F1	212231		Fuse: 4 amp
R1	74375		Resistor: wire wound, 150 ohm, 20 w
SW1	93263		Switch: toggle
T1	219441		Transformer
			Miscellaneous:
	48894		Holder: fuse
			24 V REGULATED POWER SUPPLY, 50 CYCLE
C1	921211		Capacitor: paper, 7 μf, 660 v ac
C2, C3	921212		Capacitor: electrolytic, 40,000 μf 30 v
CR1, CR2	921213		Rectifier: silicon
F1	212231		Fuse: 4 amp.
R1	74375		Resistor: w.w. 150 ohm, 20 w
SW1	93263		Switch: toggle
T1	921210		Transformer

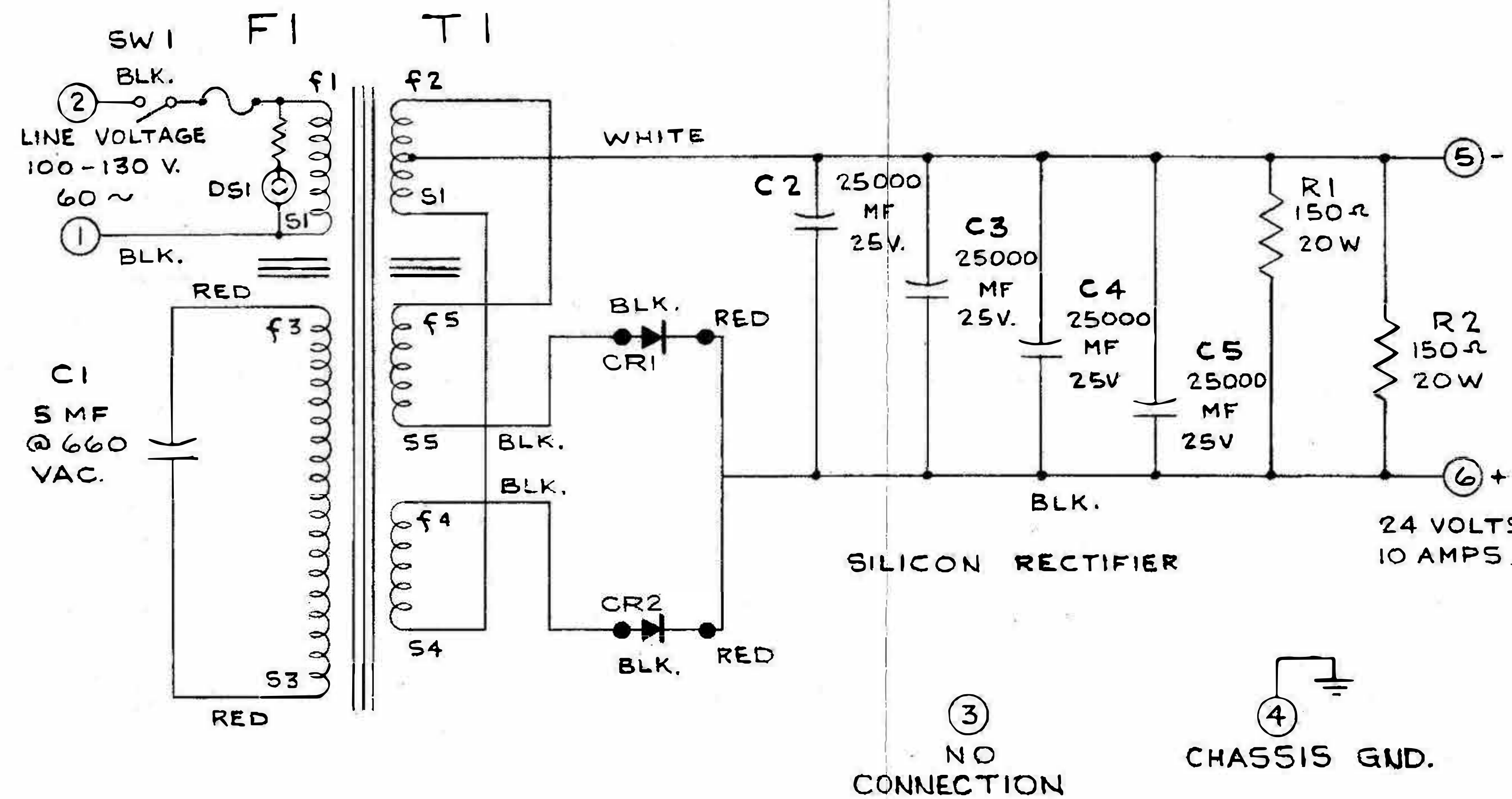


Figure RPS-3. Schematic Diagram, 24 Volt Power Supply.

Audio Filament Power Supply

UNIT 510

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

PRINTED IN U.S.A.
WA 631

IB-31156

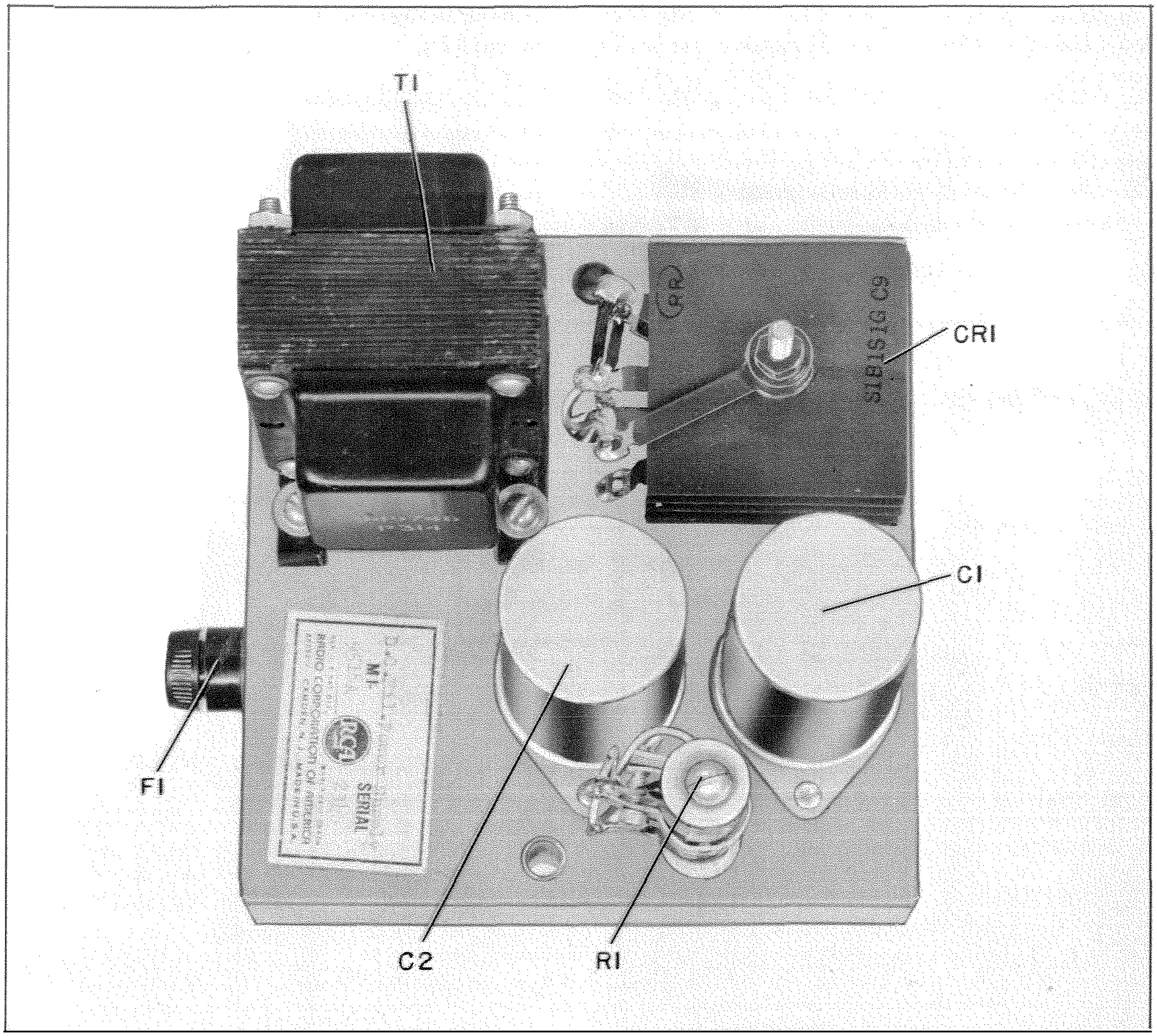


Figure AFPS-1. Audio Filament Power Supply

TECHNICAL DATA

Power

Input: 115 volts, 50/60 cycles
Output: 6.3 ± 0.2 volts dc

Rectifier Complement

1 Selenium Bridge Rectifier

Fuse

2 ampere, 250 volt slo-blo

DESCRIPTION

The Audio Filament Power Supply, figure AFPS-1, provides the 6.3 volt dc filament voltage for the tube in the first stage of the audio and cue playback preamplifiers (units 205 A and 205 G). The circuit (see schematic diagram, figure AFPS-5) consists of a power transformer, T1, a full-wave selenium bridge rectifier, CR1, and a resistance capacitance filter, C1, R1, and C2. The filter resistor, R1, is wire-wound and has a sliding tap to permit adjustment of the output voltage. A two ampere fuse, F1, in the primary circuit of transformer T1 protects the power supply from overloads.

Output Connections to Audio System

Connections between the output of the power supply and the filaments of the first stage tubes in the audio and cue playback preamplifier are shown in the

simplified schematic diagram, figure AFPS-2. The three resistors, 205R1, 2, 3 are mounted on the rear of audio shelf 205 in rack 2 (see figure AFPS-3), and the two amplifiers are plugged into connectors on the shelf. The 5-ohm resistor, 205R2, in conjunction with the 10-ohm variable resistor of the power supply sets the output voltage to the desired value.

The two 20-ohm resistors, 205R1 and 205R3 permit removal of one amplifier for servicing without danger of applying excessive filament voltage to the other amplifier. Each resistor is in series with the filament on one of the amplifiers but is normally short-circuited by a jumper on the plug of the other amplifier. Thus, when either amplifier is unplugged, the short is removed from the resistor connected to the amplifier remaining on the shelf.

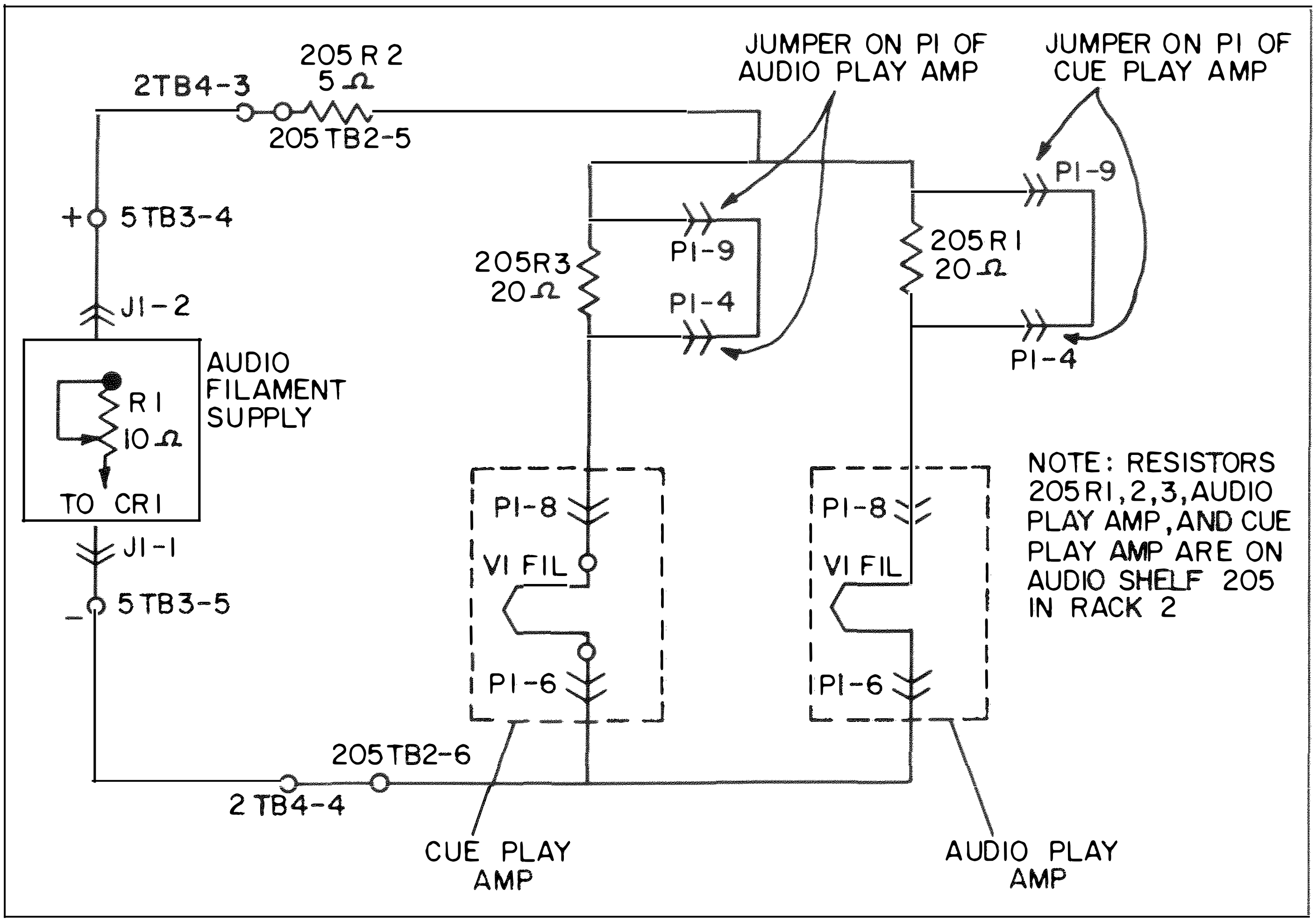


Figure AFPS-2. Power Supply Simplified Schematic Diagram

ADJUSTMENTS

Input Voltage

The primary of transformer T1 is tapped for input voltages of 105, 115, and 125 volts. As shipped the power supply is wired for 115 volt operation. If the supply voltage differs from 115 volts, connect the wire from the appropriate transformer tap to the fuse terminal in place of the red/black wire as directed in the following table.

Voltage	*Wire Color*
105	Red/Yellow
115	Red/Black
125	Red

Output Voltage

To set the filament voltage to the desired value proceed as follows:

1. Connect a dc voltmeter between the junction of resistors 205R1 and 205R2 (see figure AFPS-3) on the rear of audio shelf 205 and chassis ground.

2. Adjust the slider on resistor R1 of the power supply to obtain the desired meter reading. The reading should normally be about 6.3 volts but may be between 6.1 and 6.5 volts depending on the line voltage.

TABLE OF PROBABLE TROUBLES

Trouble	*Probable Cause*	*Remedy*
No output voltage	Fuse F1 defective	Replace fuse.
	No input voltage at jack J1 terminals 5 and 6	Determine reason and correct.
	Defective transformer T1	Replace transformer.
Low dc output voltage; hum level normal	Defective selenium rectifier CR-1	Replace rectifier.
Low dc output voltage; high hum	Defective filter capacitor	Check filter capacitors; if defective replace.

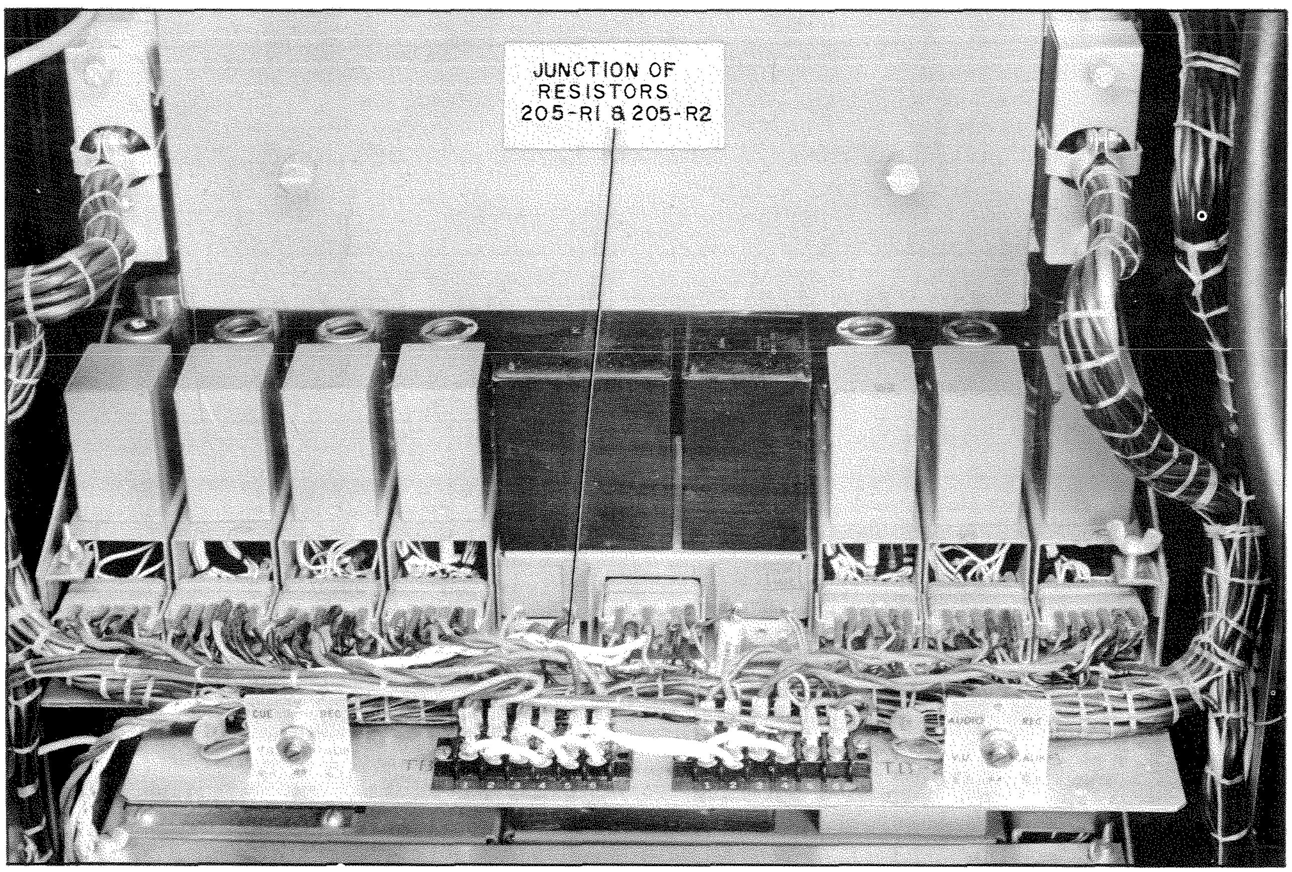


Figure AFPS-3. Audio Shelf (Unit 205), Rear View

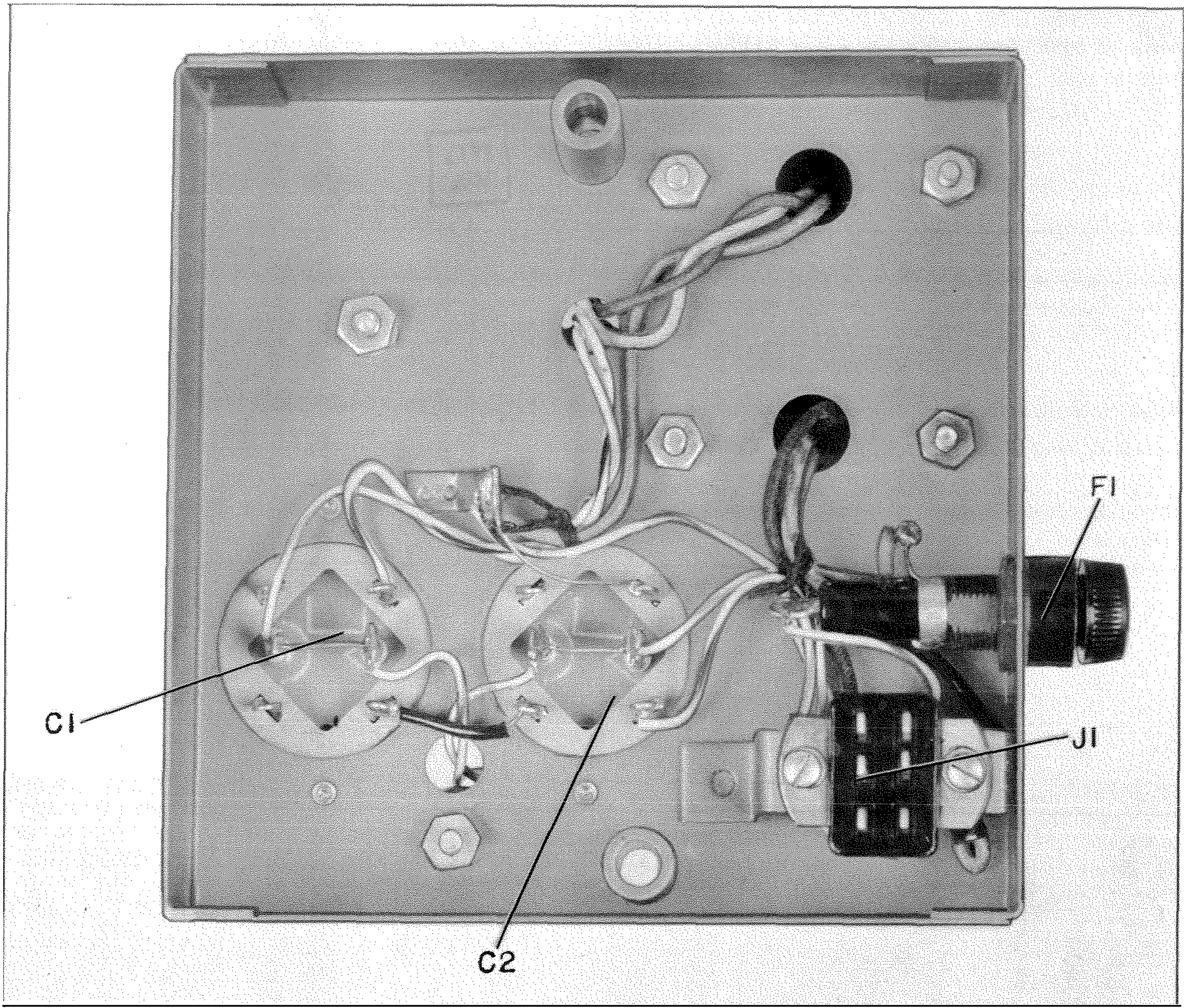


Figure AFPS-4. Audio Filament Power Supply, Rear View

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			DC FILAMENT SUPPLY (MI-9518-A)
C1-A,B, C2-A,B	59757	442900-40	Capacitor: dry electrolytic, 1000/1000 μf, 15/15 v
CR1	203040	8862325-1	Rectifier: selenium
F1	93939	990157-110	Fuse: cartridge, 2 amps, 250 v slo-blo
J1	28507	181494-3	Connector: male, 6 contact, chassis mtg.
R1	16929	182127-7	Resistor: adj. wire wound, 10 ohms ±10%, 25 w
T1	203041	949746-1	Transformer: power
XF1	48894	99088-2	Holder: fuse (for F1)

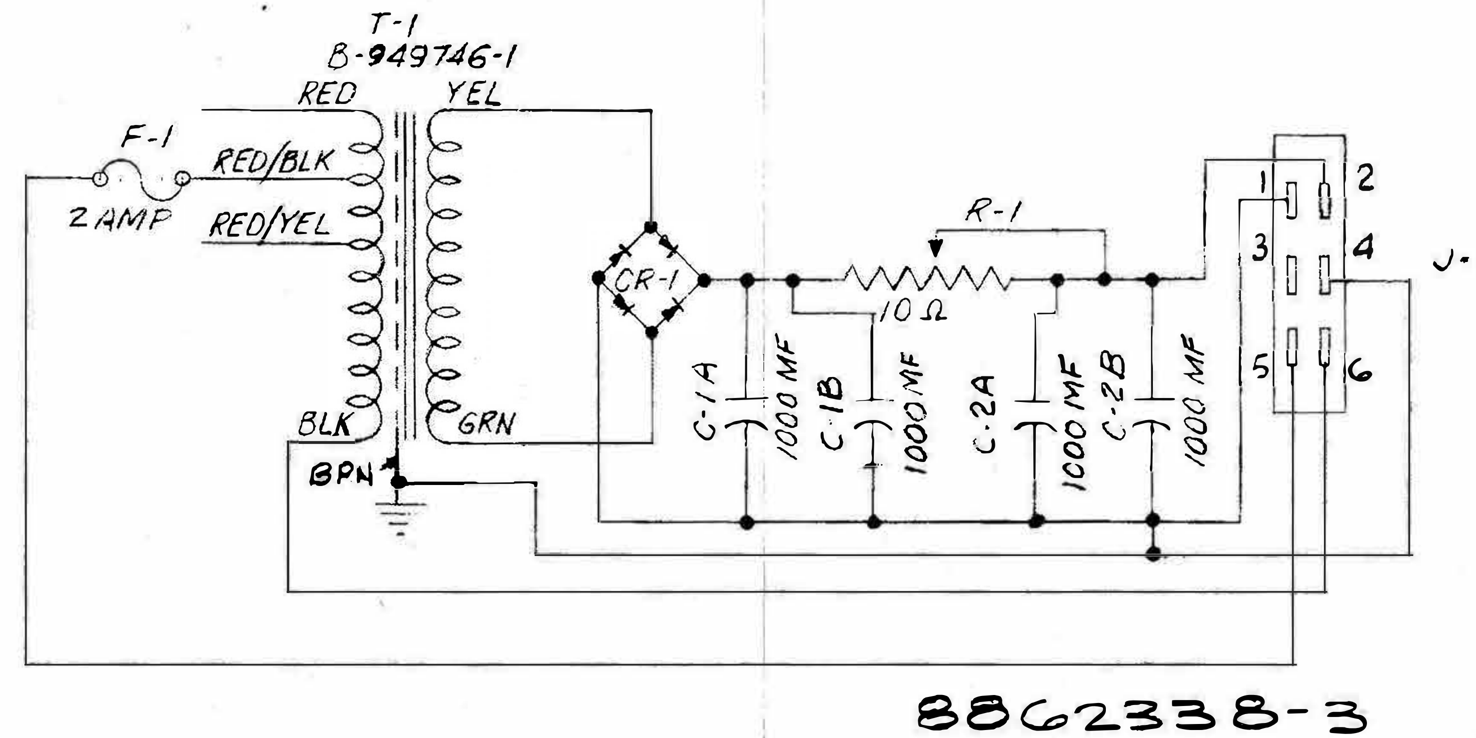


Figure AFPS-5. Audio Filament Power Supply Schematic Diagram

Air Pump

UNIT 509

RADIO CORPORATION OF AMERICA
INDUSTRIAL ELECTRONIC PRODUCTS, CAMDEN, N. J.

IB-31155

PRINTED IN U.S.A.
BR 631

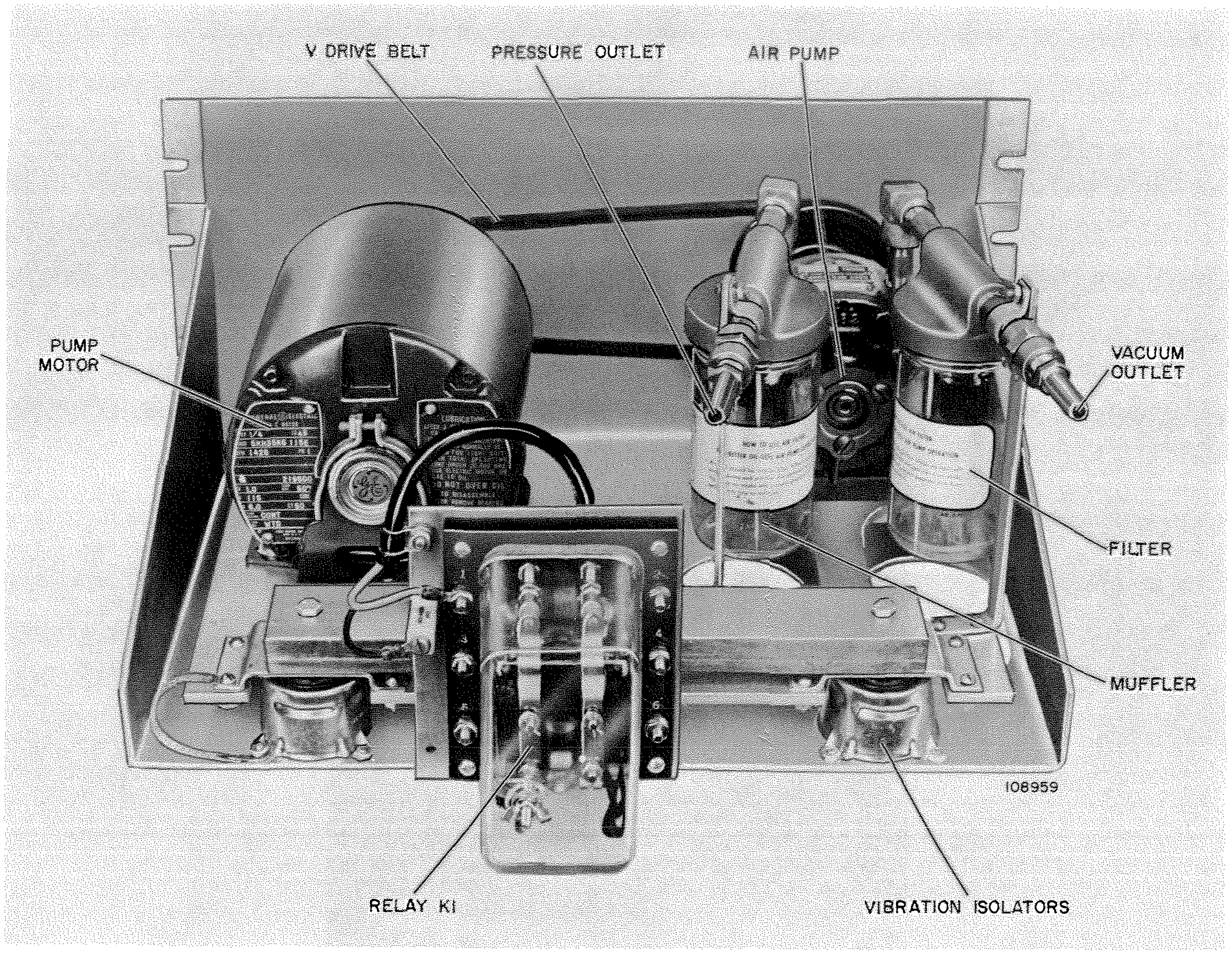


Figure AP-1. Air Pump (Rear View)

POWER REQUIRED

Motor Voltage

115 volts, 50 or 60 cycle, single phase

Relay Voltage

24 volts dc

DESCRIPTION

The Air Pump, figure AP-1, provides compressed air for the air guides on the Tape Transport Panel and vacuum for holding the tape in the vacuum guide.

The pump is an "oilless" carbon vane type which produces a vacuum at the intake and compressed air at the outlet. It is driven, through a V-belt drive, by a 1/4 horsepower, 115 volt ac, induction motor. A 24 volt dc, double-pole single-throw relay is provided to turn the pump on and off from a remote location.

The pump is mounted on a panel in a standard 19-inch equipment rack. Vibration isolators are used to prevent vibrations from being transmitted to other sections of the equipment rack.

INSTALLATION

The Air Pump is shipped in the rack. To connect it to the Tape Transport Panel proceed as follows:

1. Check the pump filter and muffler jars (see figure AP-1) to make sure they are tight.

2. Remove the four red-headed shipping screws and the four red spacers that are used to protect the vibration isolators during shipment.

3. Connect the black air hose, attached to the rear of the Tape Transport Panel, to the vacuum outlet on rear of assembly (see figure AP-1).

4. Connect the red air hose, attached to the rear of the Tape Transport Panel, to the pressure outlet on rear of assembly (see figure AP-1).

5. Push the air hoses on to the hose stems so that there is less than 1/4 inch of clearance between the end of the hose and the hex section of the hose stem,

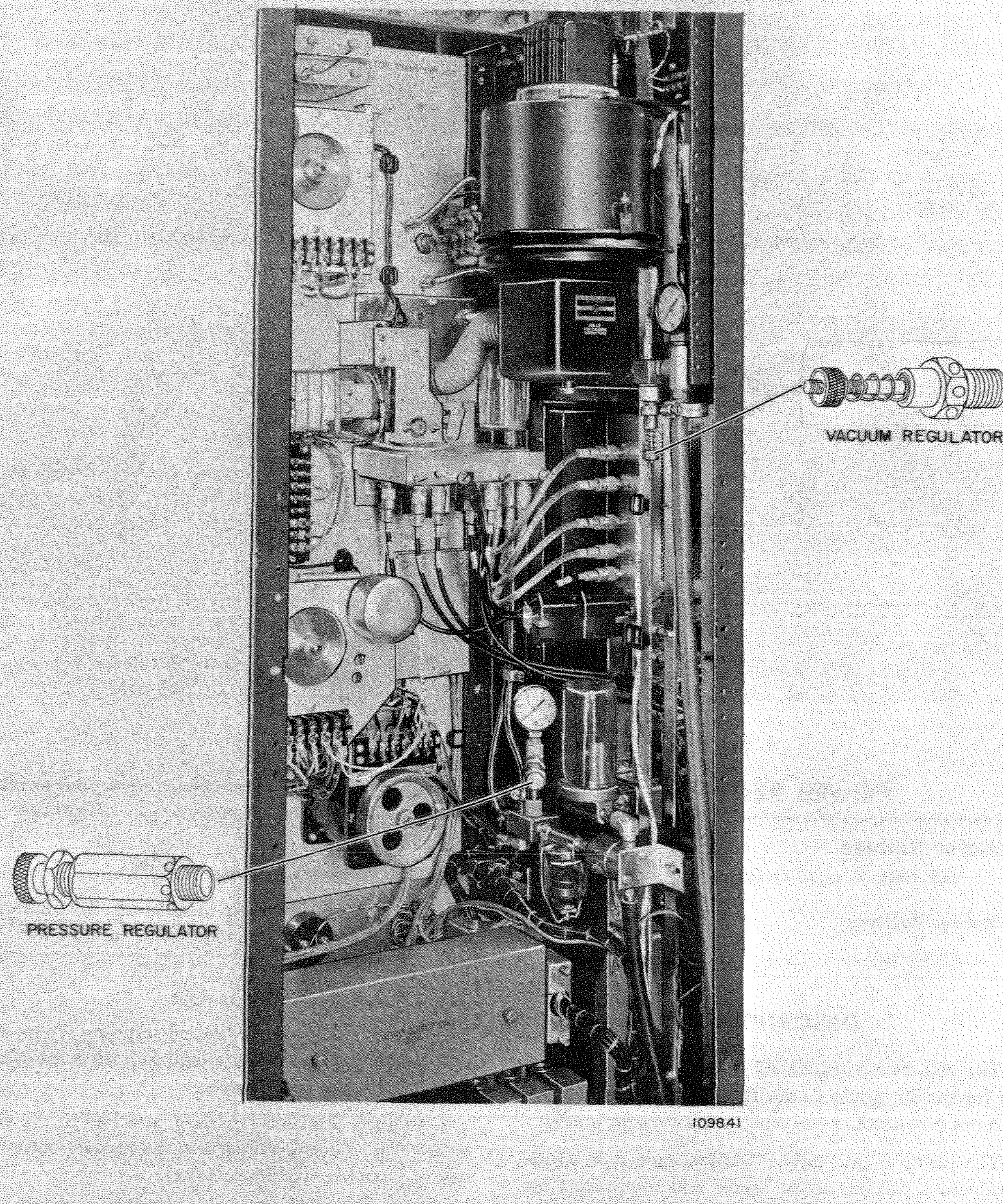


Figure AP-2. Television Tape Recorder, Rack No. 2 (Rear View)

and clamp them with the hose clamps provided. Allow enough slack in the hoses to permit free action of the vibration-isolated platform on which the pump and motor are mounted.

NOTE: If rigid lines are substituted for the rubber hoses provided, use a loop of flexible hose at least 18 inches long between the rigid lines and the outlets on the air pump.

Pressure and Vacuum Adjustments

When connections are completed, check and adjust the vacuum and pressure relief valves as follows:

1. Install a tape; correct pressure adjustments can not be made unless a tape is threaded correctly on the tape transport panel, and the tape is held correctly in the vacuum guide of the head wheel panel.

2. Check the indication on the air pressure and vacuum gages located on the rear of rack 2 before running as part of a system. The air pressure gage, which is calibrated in pounds-per-square-inch, should read 3.5 to 4.5. The vacuum gage, which is calibrated in inches of mercury, should read 4.5 to 5.5. If these readings are not obtained refer to steps 3 (vacuum adjustment) and 4 (air pressure adjustment) below.

CAUTION: Do not operate the pump for a period in excess of 3 minutes if the reading on either the vacuum or air pressure gage is over 10. The carbon vanes depend on air flow through the pump for cooling. A pressure of 10 or a vacuum of 10 indicates the flow of air through the pump is getting dangerously low. Permanent damage to the carbon vanes will result if they are overheated.

3. To adjust the vacuum relief valve (see figure AP-2) loosen the knurled jam-nut on the threaded valve-stem. Insert a screwdriver in the slotted-end and hold it to prevent rotation and turn the second knurled nut to change the spring pressure on the valve. Remove the screwdriver and read the vacuum gage (do not touch the valve-stem while reading the gage or the reading may be erroneous). Repeat the adjustment until the correct reading is obtained. Then lock the adjustment nut with the knurled jam-nut.

4. To adjust the air pressure relief valve loosen the hex type jam-nut and change the valve spring pressure by turning the knurled adjusting screw. When correct air pressure is obtained, lock the adjusting screw with the hex jam-nut.

NOTE: When making pressure adjustments always ascertain that all portions of the air and vacuum systems are in place and there are no leaks in the lines.

OPERATION

Operation of the Air Pump is completely automatic. When the tape recorder is placed in any mode of operation except STOP or R.F. COPY the Air Pump will start. The Air Pump will stop automatically after a preset time delay of approximately 45 seconds whenever the tape recorder is returned to the STOP mode of operation.

MAINTENANCE

Normally, little maintenance should be required except for cleaning the filters and lubricating the air pump motor. If major repairs are necessary either return the pump to the Gast Mfg. Corp., Benton Harbor, Michigan, for guaranteed repair service, or proceed as outlined under General Maintenance Notes.

Cleaning Filters

With the Air Pump stopped remove the filter and muffler jars, and empty out the entrapped solids. Remove the felts from the jars and wash them in a solvent such as Freon TF, alcohol, or Chlorothene. When the felts are clean and dry replace them carefully.

Flushing Pump

The pump should be flushed every two or three months. To flush the pump remove the filter assemblies and, while the pump is running, add several teaspoonfuls of Freon TF, alcohol (keep away from any open flame) or Chlorothene. When the felts are clean and dry replace them carefully.

WARNING

DO NOT USE KEROSENE

Repeat the flushing procedure and then, after all of the solvent has passed through the pump, replace the filter assemblies.

WARNING

IF THE VAPORIZED SOLVENTS SHOULD PRESENT A HAZARD IN THE ROOM IN WHICH THE PUMP IS USED, PROVISIONS SHOULD BE MADE TO EXHAUST THE FUMES OR THE PUMP SHOULD BE REMOVED TO A NON-HAZARDOUS AREA.

Lubrication

Oil the motor at least once every year with grade SAE10 or electric motor oil.

CAUTION: Never lubricate the dry oilless Air Pump. The carbon vanes and grease-sealed bearings require no oil.

Belt Tension

If belt tension is correct, the belt will deflect from 1/4 to 3/4 of an inch from a straight line when a 2-pound force is applied to the belt, midway between the sheaves (see figure AP-3). To adjust the tension loosen the motor mounting screws, and move the motor either toward or away from the pump until the specified tension is obtained. Then tighten the motor mounting screws.

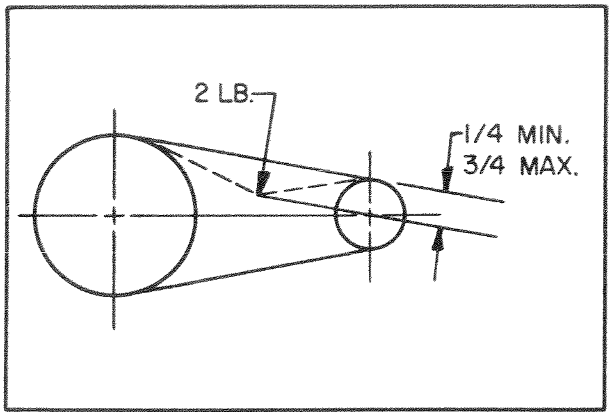


Figure AP-3. Belt Tension Adjustment

GENERAL MAINTENANCE NOTES

Belt Replacement

When replacing the belt, DO NOT force the belt over the sheaves. Loosen the motor to install the belt and adjust the tension as outlined above.

Motor

If the motor is replaced, check that the rotation of the motor agrees with the direction of rotation of the pump. If the motor rotation is incorrect, change the motor connections according to the instructions on the rear of the motor cover.

Pump

General. The basic materials used in the pump are cast iron and steel, consequently any moisture, especially when the pump stands idle, will tend to corrode the interior. This precision pump has a clearance of only .0015 of an inch between the top of the rotor and the cylinder bore, and only .003 of an inch or less clearance between each end of the rotor and the end plate. Any thrust on the shaft (such as forcing a pulley or coupling on) will tend to close these clearances. Foreign particles or excessive dirt or dust could also cause eventual jamming of pump.

Filters. The intake and exhaust filters are not interchangeable. The exhaust filter assembly is recognized by the two brass tubes that extend from the cap to almost the end of the felt filter. The vacuum filter assembly does not have these tubes. Each filter assembly must also be correctly oriented with reference to the pump. This can be determined by checking the air flow. In both cases air should flow into the glass jar first, then through the filter felt to the outlet of the filter assembly.

Carbon Vanes. The precision ground vanes are made of hard carbon and will last from 5000 to 15,000 hours depending upon the speed and degree of vacuum or pressure. Excessive dirt, foreign particles, oil, or moisture could cause the vanes to stick in the rotor slots and even break.

Periodic flushing should prevent this. To replace the carbon vanes or inspect the pump interior only the dead-end plate (opposite the drive shaft end) should be removed. Remove the end cap screws, end cap ring, and rotor spacers. The dowel pins will come off with the end plate. The bearing shim and bearing will come off with the end plate. Before removing the bearing from the end plate, mark the face of the bearing (DON'T MARK WITH A SHARP INSTRUMENT) so that it can be replaced exactly as before; also, do not damage the felt seal washer when removing the bearing. The end plate should be removed with an end plate puller, because a prying tool will damage the end plate and body surfaces.

After the pump has been disassembled and the necessary work performed reassemble it in the following order:

1. Insert the carbon vanes with the leveled edge fitting the bore.

2. Loosen the cap screws on the drive-end of the motor before replacing the end plate.

3. Place the pump in a vertical position (drive-end down). This should permit the pump rotor to rest flush on the drive-end plate. (Applying pressure on the dead-end of the shaft may help make this contact.)

4. Replace the dead-end plate and bolts, tightening every third or fourth bolt around the circumference of the plate.

5. Insert the seal washer into the undercut, and push the bearing shim and bearing squarely down on to the shaft shoulder using a pusher tool and arbor press.

6. Replace the spacers and end caps making sure all paint, dirt, and burrs are removed from the end caps and the surface of the end plate.

7. Insert and tighten the end cap screws.

8. Tighten the end cap screws on the drive end.

The preceding assembly procedure should bring the pump rotor back to its original position. Check the free movement of the rotor assembly by hand. If it binds recheck to see if the parts were replaced exactly as they were originally.

LIST OF PARTS

Symbol No.	*Stock No.*	*Drawing No.*	*Description*
			AIR PUMP ASSEMBLY (DWG. #8974474-503) 11
B1	921202	8725885-2	Motor:
CR1	219262	8981614-109	Diode: contact protector
K1	218374	8433562-1	Relay: D.P.S.T. NO
			Miscellaneous:
	218378	8979066-1	Belt: drive
	218375	8979069-1	Bushing: pump pulley
	218527		Felt: for intake or output filter
	218520	8447038-1	Filter: intake
	218373	8979707-1	Fitting: hose stem 1/4" male N.P.T. 3/8 I.D. hose
	218526		Gasket: cover
	218522		Jar: glass
	218379	426890-20	Mounting: vibration
	218521	8447035-1	Filter: outlet
	218377	8979067-4	Pulley: motor, 2.5 P.D.
	218376	8979067-3	Pulley: pump 3.2 P.D.
	218523	8725899-1	Pump only, less intake filter and outlet filter
	218525		Seal: washer
	218524		Vane: carbon

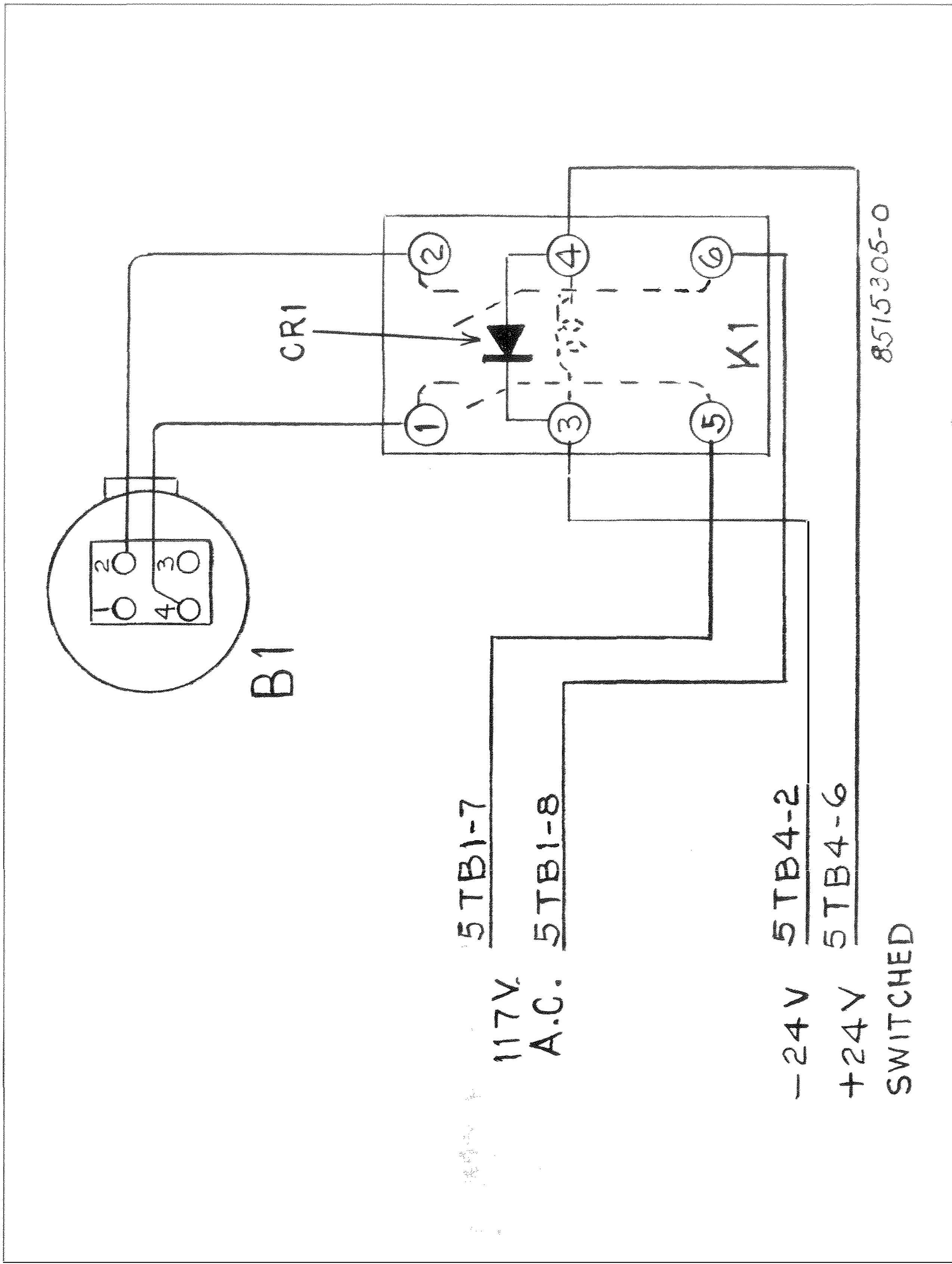


Figure AP-4. Air Pump Schematic Diagram